JOURNAL OF DAIRY SCIENCE

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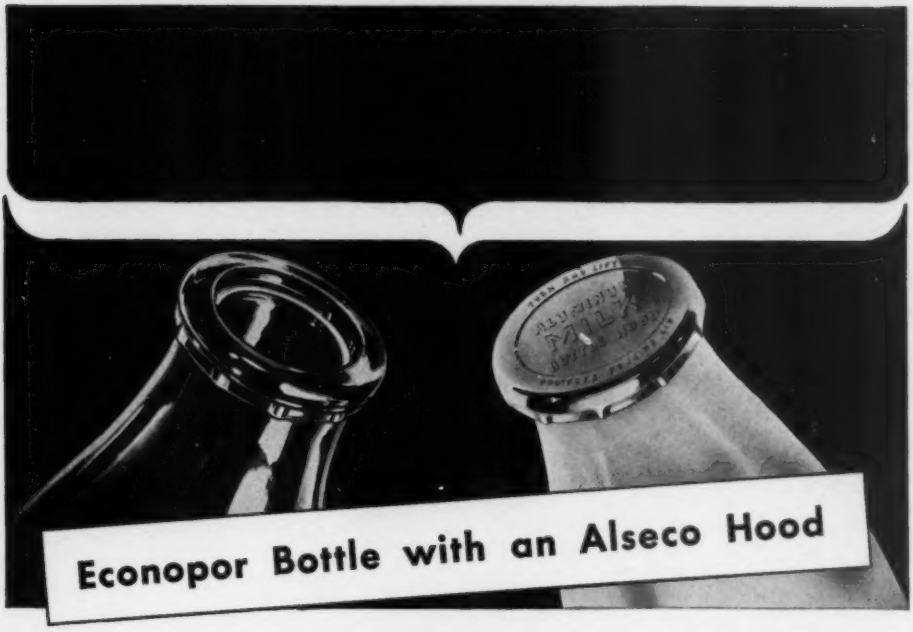

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JOURNAL OF DAIRY SCIENCE

VOLUME XXVIII AUGUST, 1945 NUMBER 8

ASCORBIC ACID OXIDATION A KEY FACTOR IN THE INHIBITION OR PROMOTION OF THE TALLOWY FLAVOR IN MILK

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It is a well-known fact that the development of the oxidized flavors in milk and milk products renders them distasteful to the human palate and is the most frequent cause of their rejection.

It is a matter of much significance that the oxidation of unsaturated fatty acids in the lipid molecules, primarily of oleic acid (11), is largely responsible for the development of the tallowy flavor. There is evidence to show that the development of oily, tallowy, and subsequently bitter flavors in the milk fat is accompanied by corresponding losses in its vitamin A and carotene contents (6, 13, 14), and that the presence of oxidized fats in the diet may not only lower the utilization of vitamin A by an animal body (15, 24), but be actually injurious to health (23).

Furthermore Pavlov's celebrated studies of the work of the digestive glands (17) indicate rather conclusively that the psychic effect upon the nutritive value of the food could not be lightly dismissed. Pavlov observed that without the assistance of appetite many foods which enter the stomach remain wholly unsupplied with gastric juice. He believed that the gastric secretion is only excitable by specific and select stimuli.

Much discussion has arisen, as to exactly which one of the lipid constituents of the milk is most susceptible to oxidation resulting in the development of the tallowy flavor. The experimental evidence tends to indicate that of all the lipids in the milk the phospholipids are the least stable ones (1, 4, 21, 22). Theoretically they are certainly more exposed to direct contact with dissolved oxygen and catalysts of the water phase of the milk, by virtue of their distribution through the milk system (12). It is also known that as compared with butter, pure milk fat retains its original good qualities for a much longer period of time, at higher than refrigeration temperatures.

However, it is important to bear in mind that irrespective of the lipids' sensitivities to oxidative catalysis, the reaction itself must be initiated first; and once it is started in the milk it might not stop at any paricular point (3).

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Many food products are obtained from milk. Thus it seemed logical to assume that their resistance to oxidation would be affected by the extent and magnitude of the respective chemical changes allowed to take place in the milk prior to processing. It was thought, therefore, that if the key factor to the system could be determined, then perhaps it would be possible to control the oxidative process and thus prevent or practically retard the development of the tallowy flavor in milk and milk products.

Since milk is invariably exposed to light and oxygen after its removal from the mammary gland, it seemed necessary to direct our attention to the problem concerning the mutual effect of these factors upon the development of the tallowy flavor. Ascorbic acid tends to disappear rather quickly in milk exposed to sunlight in the presence of lactoflavin and dissolved oxygen (10). Because of this it was thought important to learn if there is a relationship between ascorbic acid content in milk reduced to various levels by exposure to light and the development of the tallowy flavor in milk subsequently held at 0 to 5° C. in the dark.

In the past, a theory has developed that vitamin C itself was an antioxidant and that if it were increased the development of the tallowy flavor would be prevented (2, 19, 20). It was thought that if decreasing vitamin C made the deterioration worse, then when vitamin C was reduced to the limit (oxidized) the deterioration would be very bad. Previous workers have not carefully checked the results around the critical zero point. It is around this point that the new results of this study are produced. It has been found that a rapid complete oxidation of ascorbic acid in the milk to dehydroascorbic acid, either prior to or after pasteurization, prevents the development of the tallowy flavor.

The fact that vitamin C was the key factor initiating the reaction was definitely determined by the following experiments. In the original experiment photooxidation was used, the source of light being daylight diffused through a window pane. After preliminary tests had indicated that there might be an unknown relation between the time of exposure and the development of the tallowy flavor, the controlled experiment at which the discovery was confirmed was planned and executed as follows:

A batch of mixed morning's milk from many cows was obtained from the Cornell University herd. It was pasteurized at 61.6° C. (143° F.) for 30 minutes, chilled in ice water[1] and then exposed in an Erlenmeyer flask to northern daylight diffused through a window pane. The light was not strong and consequently took somewhat longer than the direct rays of sun, or light generated by a mercury vapor lamp, or a chemical oxidizing agent. The intensity of irradiation during the exposure varied from 12 to 50 foot candles as measured by a Weston light meter. The samples were removed from exposure at intervals of time up to the moment when all of the ascorbic

[1] Milk was cooled to 5° C.

acid was photooxidized. After exposure these samples were immediately stored in the absence of light at 0 to 5° C. (32 to 41° F.). The changes in the ascorbic acid content of the samples were followed by direct titration with 2,6-dichlorophenol-indophenol in acid solution (18). The judging was done on the basis of the score card recently revised by the American Dairy Science Association.

The results are shown in figure 1. The diminution of ascorbic acid with the passage of time and exposure to light is shown in the lower set of the

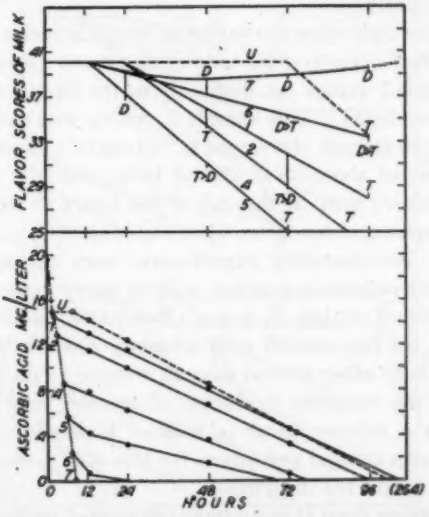

FIG. 1. The relationship between the time of exposure to northern daylight, ascorbic acid content (lower part), and the production of daylight (D) and tallow (T) flavors in pasteurized mixed milk. The numbers 1, 2, 4, 5, 6, and 7 at the points of intersection between the vertically sloped dotted line and solid more horizontal ones, indicate the hours of exposure and corresponding ascorbic acid contents of the samples prior to their storage in absence of light at 0 to 5° C. The thick solid lines (upper part of the figure) labeled by numbers and letters D and T indicate the hours of exposure prior to storage and respective flavor scores of milk throughout the experiment. The intensity of irradiation during the exposure varied from 12 up to 50 foot candles. The flavor scores indicate: 40, no criticism; 35–40, acceptable; and 25, unsuitable for consumption. Symbol U indicates control-unexposed sample of milk.

curves. Ascorbic acid in the various samples was photooxidized for 1, 2, 4, 5, 6, and 7 hours, respectively, with the resulting depletion of the ascorbic acid, as indicated along the dotted line. The upper set of the curves has the same scale, with the axis of ordinate indicating flavor score according to the standardized score card.

It is apparent that an initial exposure to daylight did not stimulate a more rapid decrease in ascorbic acid content of the samples when the latter were subsequently placed in the dark at 0 to 5° C.

The comparison between the data of the upper and lower parts of the figure indicates that whereas partial photooxidation of ascorbic acid in the milk, prior to its storage in the dark, *stimulates the development of the tallowy flavor, its complete oxidation prevents the development of the tallowy flavor.*

Although the unexposed control sample retained its original no criticism flavor up to 72 hours, the samples exposed for 1, 2, 4, and 5 hours developed tallowy flavor at the end of a holding period of 48 hours and continued to get worse very rapidly.

However, at the time when the oxidation of the ascorbic acid was nearing completion, sample 6 developed the tallowy flavor more slowly than the other samples and sample 7 stands out distinctly as the one in which the tallowy flavor was not developed. This sample 7, which was entirely depleted of ascorbic acid before storage, developed a "daylight" flavor, but maintained a good flavor score of about 38 to 39 and then gradually improved (losing its "daylight" flavor) until at the end of 264 hours its flavor was about as good as at the start.

Subsequently, corroboratory experiments were run using two lots of milk. The first lot represented mixed milk of many cows in which the tallowy flavor developed within 24 hours after pasteurization (+ on chart); while the second lot represented milk of many cows in which the tallowy flavor developed only after several days in storage (– on chart). This was done to learn if the complete oxidation of ascorbic acid will prevent the development of the tallowy flavor in milk of both poor- and fair-keeping qualities. The experimental procedure for this study was the same as that of the experiment reported in figure 1.

The data resulting from this study are presented in figure 2. The lower part of this figure deals with milk that was exposed fresh, while the upper part deals with the same milk, but which prior to exposure was held for 24 hours at 0 to 5° C. The results of these further experiments were essentially the same as those presented in figure 1.

In this connection it should be noted that both lots of milk were exposed to daylight prior to pasteurization as well. The relationship between the time of exposure prior to pasteurization and the development of the tallowy flavor was found to be the same as for the milk which was pasteurized prior to exposure. It should also be mentioned that some of the milk which was exposed raw was not yet wholly depleted of its ascorbic acid content at the end of exposure. After exposure, the sample was pasteurized (7A) during which time the remainder of the ascorbic acid was oxidized. It scored 40 on flavor at the end of 264 hours.

In order to ascertain whether the results were definitely due to the presence or absence of ascorbic acid and not to some other factor in the treatment, it was necessary to corroborate the results by an experiment in which

ascorbic acid was the only variable factor. This was done by finding out if the addition of ascorbic acid would again induce the production of the tallowy flavor.

To test this point a sample of freshly mixed milk from many cows was pasteurized, chilled in ice water,[2] and then exposed to daylight. A portion of this milk was exposed to the point when only a part of ascorbic acid was oxidized (table 1, column B), while the other portion was exposed to the

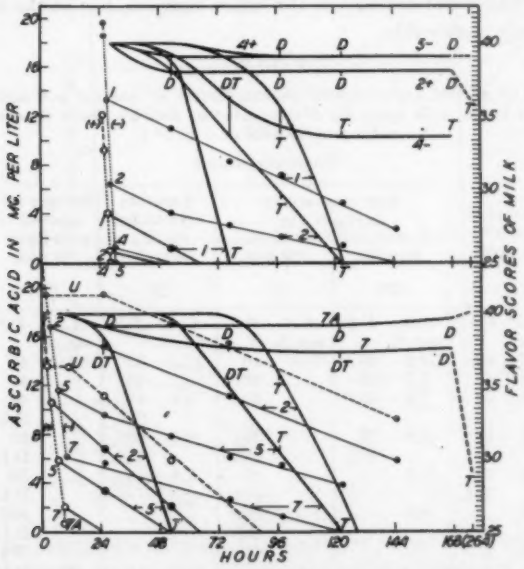

FIG. 2. The relationship between the time of exposure to northern daylight, ascorbic acid content, and the production of daylight and tallowy flavors in poor (+) and fair (−) keeping quality milk. The numbers 1, 2, 4, 5, and 7 at the points of intersection between vertically sloped dotted lines (+) and (−), and solid more horizontal ones, indicate the hours of exposure and corresponding ascorbic acid contents of the samples prior to their storage in absence of light at 0 to 5° C. The thick solid lines labeled by numbers individually or in conjunction with vitamin C lines, and by letters D (daylight flavor) and T (tallowy flavor) indicate the hours of exposure prior to storage and the respective flavor scores of milk throughout the experiment. The intensity of irradiation during the exposure varied from 25 to 50 foot candles.

point when the ascorbic acid was just completely oxidized (column C). This latter portion was divided into two parts. One part was retained as a control sample, containing no ascorbic acid (column C), whereas the other one was fortified with 17.3 mg. per liter of ascorbic acid (column D). In turn, one-half of the milk to which ascorbic acid had been added was re-exposed to sunlight to the point when the ascorbic acid was completely oxidized (column

[2] Milk was cooled to 5° C.

E). Again to one-half of the resulting sample ascorbic acid was added prior to storage (column F). All of the samples were stored at 0 to 5° C. in the dark and analyzed daily.

The results (table 1) were that the tallowy flavor developed in all samples of milk containing natural or added ascorbic acid prior to storage, whereas the samples in which the ascorbic acid was completely oxidized by exposure or re-exposure to light did not develop the tallowy flavor. Some "daylight" flavor did develop in the latter samples, but at the end of 7 days it was scarcely noticeable.

TABLE 1

The effects of partial and complete photooxidation of natural and added ascorbic acids in the milk upon the development of tallowy flavor in samples subsequently held at 0 to 5° C.

Pasteurized milk

Held at 0 to 5 °C.	Untreated control sample (A)		Milk exposed to daylight for 20 min. (B)		Milk exposed to daylight for 120 min. (C)		Ascorbic acid added to (C) sample (D)		Sample (D) exposed to sunlight 20 min. (E)		Ascorbic acid added to (E) sample (F)	
Days	*A.A.** mg./l.	*F.S.**	*A.A.* mg./l.	*F.S.*	*A.A.* mg./l.	*F.S.*	*A.A.* mg./l.	*F.S.*	*A.A.* mg./l.	*F.S.*	*A.A.* mg./l.	*F.S.*
0	16.5	40	10.9	40	00.0	40	17.3	40	00.0	40	15.9	40
1	14.4	40	7.7	40	.....	40	13.7	40	.....	40	13.0	40
2	12.6	40	5.9	40	.....	40	9.8	37 Tal.	.....	40 D.L.	9.8	40 D.L.
3	11.2	40	3.8	25 Tal.	.....	39½ D.L.	6.6	25 Tal.	.....	39 D.L.	2.4	25 Tal.
4	8.5	25 Tal.	1.7	.....	.....	39 D.L.	3.8	.....	.....	39 D.L.	1.4	.....
5	5.6	.....	0.0	.....	.....	39½ D.L.	.....	.....	.....	39½ D.L.	0.0	.....
7	3.1	.....	.....	.....	.....	40	.....	.....	.....	39½ D.L.	.....	.....

* A.A.—ascorbic acid; F.S.—flavor score.
Remarks: Flavor score indicates: 40, no criticism.
35–40, acceptable to most consumers.
25, unsuitable for consumption.
Symbols indicate: D.L., daylight; and Tal., tallowy flavors, respectively.

It appears, therefore, that the reaction which produces tallowy flavor can be inhibited by rapid and complete oxidation of ascorbic acid, and can be induced again by the addition of ascorbic acid.

Consequently it was of interest to learn if the complete oxidation of ascorbic acid by an oxidizing agent would also prevent the tallowy flavor in milk.

Greenbank (5) reported that by varying the quantities of 30 per cent hydrogen peroxide added to milk from 0.03 to 0.50 ml. per liter, the oxidized flavor could be either promoted or inhibited. Our preliminary experiments indicated that these amounts were in excess of that required to oxidize the ascorbic acid in milk.

Since we were interested in both complete and partial oxidation of ascorbic acid, the upper limit for the volume of hydrogen peroxide to be added to milk in many cases was governed by the amounts necessary to oxidize the original quantity of ascorbic acid only. Such a lot of milk was diluted in sequence with untreated milk to produce a series of samples containing: 0.028, 0.021, 0.016, 0.012, 0.009, and 0.0067 ml. of 30 per cent hydrogen peroxide (aqueous solution) per liter of milk, respectively. Three to five minutes of time were required to prepare the series.

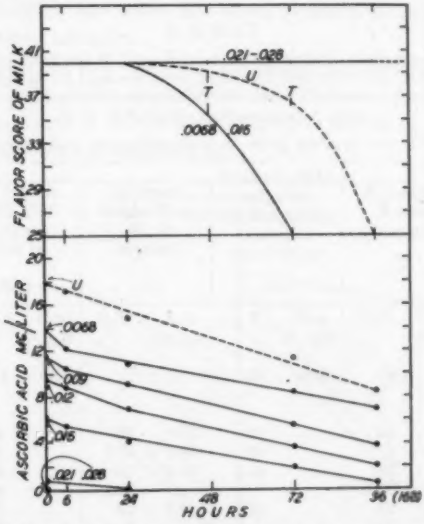

FIG. 3. The relationship between the amounts of 30 per cent hydrogen peroxide added to milk, ascorbic acid content (lower part) and the production of tallowy (T) flavor in pasteurized mixed milk. Milk was cooled to 15° C. prior to hydrogen peroxide treatment. The numbers 0.0068, 0.009, 0.012, 0.016, 0.021, 0.028 at the points of intersection between the axis of ordinate and solid horizontally sloped lines, indicate ml. of 30 per cent hydrogen peroxide per liter of milk and corresponding ascorbic acid contents of the samples prior to their storage in absence of light at 0 to 5° C.

The data obtained are presented in figure 3. The diminution of ascorbic acid with increase in volume of hydrogen peroxide as determined immediately after its addition to milk, is shown along the axis of the ordinate in the lower set of the curves. The upper set deals with the flavor score of the samples. The results of this experiment are in good agreement with the original ones of figure 1 and at the present time require no further discussion.

In order to prove that in this experiment, as in the photochemical one, the prevention of tallowy flavor in milk resulted from a complete oxidation of ascorbic acid prior to the storage of the milk in the dark, and not from any other factor, it was again necessary to corroborate it by an experiment in which ascorbic acid was the only variable.

For this purpose a sample of fresh mixed raw milk (25–28° C.) was divided into two parts. One part of it was depleted of ascorbic acid by the exposure of milk to light generated by a mercury vapor lamp; in the other one ascorbic acid was depleted by added hydrogen peroxide. Then the samples were immediately pasteurized and treated as follows: one-half of each sample was retained as a control containing no ascorbic acid (table 2, columns B and D respectively), whereas the two others were fortified with ascorbic acid (columns C and E). They were then stored in the dark at 0 to 5° C.

TABLE 2

The effects of rapid complete oxidation of ascorbic acid in the milk either photochemically or by hydrogen peroxide and of added ascorbic acid to sample completely depleted of its content upon the development of tallowy flavor in milk subsequently held at 0 to 5° C.

Milk was treated prior to pasteurization and storage

Held at 0 to 5° C.	Untreated control sample (A)		Milk exposed to light generated by mercury vapor lamp (B)		Ascorbic acid added to (B) sample (C)		0.1 ml. of 30% H_2O_2 per liter of milk (D)		Ascorbic acid added to (D) sample (E)	
Days	*A.A.** *mg./l.*	*F.S.**	*A.A.* *mg./l.*	*F.S.*	*A.A.* *mg./l.*	*F.S.*	*A.A.* *mg./l.*	*F.S.*	*A.A.* *mg./l.*	*F.S.*
After treat. and pasteurization	19.0	40	0.00	40	.....	.....	00.0	40	.....	.....
1	13.4	40	.....	40	19.4	40	.....	40	20.1	40
3	12.0	40	.....	40?	16.6	40?	.....	40	17.3	Tal.
5	7.0	36 Tal.	.....	40?	10.2	32 Tal.	.....	40 Sl.C.	9.5	25 Tal.
7	2.1	25 Tal.	.....	40?	4.2	25 Tal.	.....	40 Sl.C.	3.9	Extr. Tal.
	0.0	Extr. Tal.	.....	40	0.0	Extr. Tal.	.....	40	0.0	.....

* A.A.—ascorbic acid; F.S — avor score.
Remarks: Sample (B) was ..posed for 20 min.
Flavor score indicates: 40, no criticism.
35–40, acceptable to most consumers.
25, unsuitable for consumption.
Symbols indicate: ?, daylight flavor hardly recognizable;
Tal., tallowy and C., cooked flavor respectively.

The data presented in table 2 show that the reactions which produce the tallowy flavor could be inhibited by the quick complete oxidation of ascorbic acid, either photochemically or by an oxidizing agent, and can be induced again by the addition of ascorbic acid.

There remains to be considered some of the evidence for the promotion of the tallowy flavor in milk by added copper. The most direct approach to the problem obviously would be one involving the addition of copper to milk which was completely depleted of its ascorbic acid by either one of the two methods described. However, recent studies (8) tend to indicate that

vitamin C in milk is represented by both ascorbic and dehydroascorbic acids, and that the latter is the less stable form, being easily destroyed by heat. It has been reported also that the oxidation of ascorbic acid by hydrogen peroxide yields products which no longer can be reduced with a resting suspension of *Bacterium coli* (7).

Thus in order to learn if the promotion of the tallowy flavor in milk by added copper bears any relation to the vitamin C oxidative system, it was necessary to determine, first, the extent of the oxidation of ascorbic acid to dehydroascorbic acid, and then the total vitamin C content of the subsequently pasteurized samples.

The photochemical and chemical oxidation of ascorbic acid to dehydroascorbic acid in milk at 25° C. with increase of time of exposure, on the one hand, and the increase in volumes of hydrogen peroxide, on the other hand, are graphically presented in figure 4.

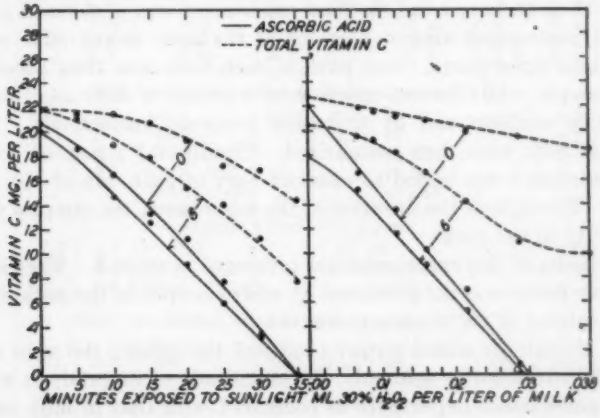

FIG. 4. The oxidation of ascorbic acid in the milk into dehydroascorbic acid either by its exposure to sunlight or by added hydrogen peroxide. The numbers 0, 6, and 8 indicate the vitamin C content of the samples immediately after treatment and at the end of 6 and 8 hours' holding period at 0 to 5° C. in the dark, respectively.

The experimental procedure was the same as previously described, with the exception that the milk of the first series of samples was exposed to sunlight in quart bottles filled to the top and for periods of time ranging from 5 up to 35 minutes. The samples were analyzed for their vitamin C contents immediately after the treatment and at the end of 6 and 8 hours. During that time they were stored in the dark at 0 to 5° C. The total vitamin C content was determined by the Gunsalus and Hand method (7), involving the reduction of dehydroascorbic acid with a resting suspension of *Bacterium coli*, followed by direct titration of ascorbic acid with 2,6-dichlorophenol-indophenol in an acid solution.

It should be stated that although the picture presented in figure 4 was found to be essentially the same for both raw and pasteurized milk samples, the subsequent pasteurization of raw milk tends to destroy all of the dehydroascorbic acid and to reduce appreciably the residual ascorbic acid content of the samples. However, the small amounts of dehydroascorbic acid could be detected in the samples, depending upon how quickly they were analyzed after the heat treatment.

The data of figure 4 also indicate that there might be a relationship between the initial amounts of dehydroascorbic acid present and the rates of its destruction in samples subsequently held at 0 to 5° C.

Thus it becomes evident that pasteurization of milk prior to forced and complete oxidation of ascorbic acid on the one hand or after it on the other, would result either in the retention of dehydroascorbic acid only, or in complete depletion of milk of its total vitamin C content.

With these facts in mind the final experiment was performed as follows. Raw and pasteurized aliquot portions of the same mixed milk were each divided into three parts. One part of each milk was then retained as a control sample, while the two others were depleted of their ascorbic acid by exposure to sunlight and by hydrogen peroxide, respectively. The raw samples of milk were then pasteurized. Finally, 0.1 p.p.m. of copper (as copper sulphate) was added to one-half part of each one of the resulting samples. Throughout the duration of the experiment, the samples were held at 0 to 5° C. in the dark.

The results of this experiment are presented in table 3. They show that the tallowy flavor was not promoted by added copper in the milk which was wholly depleted of its vitamin C content.

Even though the added copper promoted the tallowy flavor in milk containing dehydroascorbic acid only, the magnitude of its catalysis was found to be of much lesser importance as compared with that in milk containing ascorbic acid as well. This is evident from the fact that whereas in the milk containing ascorbic acid the intense tallowy flavor developed within the first 24 hours of storage; the low intensity tallowy flavor was detected in the milk containing dehydroascorbic acid only, at the end of the 5th day of storage.

There is good reason to believe that if the hydrogen peroxide were formed in the photochemical reaction (9), it might oxidize the residual ascorbic acid as in the milk to which it was added. Thus if a trace of hydrogen peroxide were present in the milk at the point when all of the ascorbic acid were oxidized, it might initiate at much slower rate, in the presence of a suitable catalyst, the breakdown of a lipid fraction of the milk during storage at 0 to 5° C. This would explain the slow promotion by added copper of the tallowy flavor in the milk containing dehydroascorbic acid only, since the traces of hydrogen peroxide left over after the forced oxidation of ascorbic acid were enough to start the breakdown of the lipid fraction of the milk, but not enough to promote it rapidly.

The situation is different, however, when the raw milk is depleted of its ascorbic acid by rapid oxidative process and then pasteurized, since the resulting by-products of the first reaction are destroyed by the following heat treatment. In such a milk the tallowy flavor was not promoted by

TABLE 3

The effects of rapid complete oxidation of ascorbic acid in the milk into dehydroascorbic acid prior to or after pasteurization either photochemically or by hydrogen peroxide and of added copper upon the development of tallowy flavor in samples subsequently held at 0 to 5° C.

The values are given in mg. per liter

Held at 0 to 5° C. (Days)	Untreated control sample			Milk exposed to sunlight for 25 minutes			0.028 ml. of 30% H_2O_2 per liter of milk		
	Ascorbic acid	Dehydroascorbic acid	Flavor score	Ascorbic acid	Dehydroascorbic acid	Flavor score	Ascorbic acid	Dehydroascorbic acid	Flavor score
	Milk was treated after pasteurization at 25° C.								
0	15.4	1.0	40	00.0	10.4	40	00.0	9.7	40
1	12.7	3.7	40	.....	4.7	40	.....	4.7	40
4	1.3	5.7	29 Tal.	.....	0.0	39 D.L.	.....	0.0	40
7	.....	0.0	Extr. Tal.	.....	.....	40 D.L.?	.....	.....	40½
19	.....	.....	Extr. Tal.	.....	.....	40 Old	.....	.....	40
	Copper added—0.1 p.p.m.								
1	7.4	7.3	Tal.	.....	4.7	40	.....	4.7	40
5	0.0	3.4	Extr. Tal.	.....	0.0	37 Tal.	.....	0.0	39 Tal.
7	.....	0.0	Extr. Tal.	.....	.....	30 Tal.	.....	.....	37 Tal.
	Milk was treated prior to pasteurization at 25° C.								
Before pasteur.	20.7	0.7	40	00.0	15.7	40	00.0	18.4	40
After pasteur.	15.4	1.0	40	.....	00.0	40	.....	00.0	40
1	12.7	4.0	40	.....	.....	41	.....	.....	40 Sl.C.
4	1.3	5.7	29 Tal.	.....	.....	40½	.....	.....	40 Sl.C.
7	0.0	0.0	Extr. Tal.	.....	.....	40	.....	.....	40 Sl.C.
19	.....	.....	Extr. Tal.	.....	.....	40	.....	.....	40
	Copper added—0.1 p.p.m.								
1	7.7	7.0	Tal.	.....	.....	41	.....	.....	40
7	0.0	0.0	Extr. Tal.	.....	.....	40	.....	.....	40
19	.....	.....	.....	.....	.....	40 Fine	.....	.....	40 Old

Remarks: Symbols indicate: D.L., daylight; Tal., tallowy; and Sl.C., slightly cooked flavors, respectively.
Copper was added after pasteurization and prior to storage.

copper, or as the additional data indicate, even by small amounts of hydrogen peroxide when added alone. Although the low intense tallowy flavor developed at the end of the 9th day of storage in a portion of milk to which both hydrogen peroxide and copper were added, its catalysis appeared to be again of much lesser importance as compared with that in milk containing

ascorbic acid added either alone or with copper which developed the intense tallowy flavor at the end of the first 24 hours of storage.

In conclusion it should be noted that the samples of milk described in the preceding paragraphs were uniformly agitated and thus brought in contact with the atmospheric oxygen not only prior to storage at 0 to 5° C. in the dark, but also daily prior to analysis. Under these conditions, as much as

TABLE 4

The effect of churning of the cream separated from the milk which was completely depleted of its total vitamin C content either photochemicallly or by added hydrogen peroxide and subsequent pasteurization procedure, upon the development of the tallowy flavor of buttermilk during storage at 0–5° C.

Held at 0 to 5 °C.	Buttermilk churned from the cream separated from: Untreated control buttermilk (A)		Milk exposed to daylight for 60 minutes: (B)		Ascorbic acid added to (B) buttermilk (C)		Untreated control buttermilk (D)		Milk treated with 0.03 ml. 30% H_2O_2 per liter: (E)		Ascorbic acid added to (E) buttermilk (F)	
Days	*A.A.* mg./l.*	*F.S.**	*A.A. mg./l.*	*F.S.*	*A.A. mg./l.*	*F.S.*	*A.A. mg./l.*	*F.S.*	*A.A. mg./l.*	*F.S.*	*A.A. mg./l.*	*F.S.*
After churned	8.6	40	00.0	40	25.4	40	10.6	40	00.0	40	22.3	40
1	4.1	40	.....	40	19.5	40	4.4	33 Tal.	.....	40	12.6	40
2	1.4	33 Tal.	.....	40	15.0	36 Tal.	0.6	30 Tal.	.....	40	3.4	25 Tal.
3	0.0	Extr. Tal.	.....	40	8.5	30 Tal.	0.0	25 Tal.	.....	40	0.0	Extr. Tal.
6	.....	Extr. Tal.	.....	40	.....	Extr. Tal.	.....	Extr. Tal.	.....	40	.....	Extr. Tal.
	Copper added—0.1 p.p.m.											
1	1.7	36 Tal.	.....	40	15.4	29 Tal.	0.6	Extr. Tal.	.....	40	7.2	25 Tal.
2	0.0	Extr. Tal.	.....	40	4.4	Extr. Tal.	0.0	Extr. Tal.	.....	40	0.0	Extr. Tal.
6	.....	Extr. Tal.	.....	40	0.0	Extr. Tal.	.....	Extr. Tal.	.....	40	.....	Extr. Tal.

* A.A.—ascorbic acid; F.S.—flavor score.

Remarks: The experiments were performed using two batches of milk from the same cows on two different days.

Symbols and flavor scores—See table 2, footnote.

8 mg. of oxygen per liter of milk were found in the sample completely depleted of its vitamin C content and yet even in the presence of added copper the tallowy flavor was not developed.

It is obvious that the differences in the susceptibilities to the development of the tallowy flavor observed between the samples of milk which were depleted either of their ascorbic acid or of total vitamin C contents on one

hand, and the control samples containing natural or readded ascorbic acid on the other, were not due to the exhaustion of oxygen in one case or its abundance in the other. This is beautifully illustrated by the data presented in table 4.

It is a well-known fact that buttermilk is more susceptible to the development of the tallowy flavor than whole milk. The data of table 4 concerning the development of the tallowy flavor in the buttermilks churned from creams separated from the milk which was previously depleted of its total vitamin C content not only photochemically but by added hydrogen peroxide as well, show clearly that the samples of buttermilk containing natural or readded ascorbic acid developed the tallowy flavor at the end of the second day, and in the samples containing added copper at the end of the first day of the holding period at 0 to 5° C. in the dark. No trace of the tallowy or any other flavors was detected through the duration of the experiment in the samples completely depleted of their total vitamin C contents. It is evident that by the separation of whole milk, churning of the cream, and by daily handling of the samples, the atmospheric oxygen was continuously incorporated.

We also observed that when the milk is subjected to careful treatment so that the vitamin C is quickly oxidized and in the case of light exposure in the shortest possible time, no off flavor whatsoever developed. This is especially true when milk was treated prior to pasteurization. (The effect of hydrogen peroxide is practically instantaneous.)

From all that has gone before, it is apparent that ascorbic acid oxidation in the milk during storage at 0 to 5° C. is undoubtedly an essential link in the chain of the reactions resulting in the development of the tallowy flavor. This observation has been confirmed to a certain extent by the previous work of Olson and Brown (16) concerning the development of the tallowy flavor in washed cream. In addition, we have found that the reaction which produces the tallowy flavor in the milk could be inhibited by a rapid complete oxidation of ascorbic acid to dehydroascorbic acid and subsequent pasteurization procedure.

The experiments discussed in the preceding paragraphs were repeated during the past several years involving many hundreds of samples. An extensive study of this problem in relation to the keeping qualities of the milk products and the systems involved is being continued.

SUMMARY

1. Ascorbic acid oxidation in the milk during storage at low temperature is an essential link in a chain of the reactions resulting in the development of the tallowy flavor.

2. The reaction which produces the tallowy flavor could be inhibited by quick and complete photochemical or chemical oxidation of ascorbic acid in

the milk to dehydroascorbic acid prior to its pasteurization and storage. Partial oxidation of ascorbic acid stimulates the development of the tallowy flavor.

3. The promotion of the tallowy flavor by added copper (0.1 p.p.m.) in the presence of dehydroascorbic acid only, is much less effective as compared with that in milk containing ascorbic acid.

4. The tallowy flavor is not promoted by added copper (0.1 p.p.m.) in the milk completely depleted of its total vitamin C content by quick oxidation of ascorbic acid to dehydroascorbic acid and the subsequent heat treatment that takes place in pasteurization.

5. The reaction which produces the tallowy flavor could be induced again by the addition of ascorbic acid to milk which was first depleted of its ascorbic acid or of the total vitamin C content.

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THE INFLUENCE OF MILK-FAT GLOBULE SIZE AND MILK AND CREAM TEMPERATURES ON THE STABILITY OF THE FROZEN CREAM EMULSION

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Cream is sometimes frozen and held in storage for subsequent use in making ice cream and soft cheeses (2). In incorporating the thawed cream into these products, the fat must be redispersed by homogenization because it has a tendency to oil off.

If cream could be preserved in a frozen condition without destabilizing the emulsion, frozen cream would be of greater commercial interest.

This paper is based on a study of some of the factors which influence the resistance of the fat emulsion in cream to the destabilizing forces of freezing and brief storage.

EXPERIMENTAL METHODS

The milk was selected from the Bureau of Dairy Industry herd at Beltsville, Md., warmed or cooled if required by the experiment, and delivered to the Bureau's research laboratories in Washington, D. C.

In Washington the milk was separated at various temperatures, and the raw cream was standardized to the desired fat content by the addition of skim milk obtained in the same separation.

Portions of the cream were pasteurized by heating them in small, stainless-steel containers to the pasteurizing temperature (usually 80° C.) and holding and cooling, or cooling without holding, to 30°[1] to 37° C.

Nine-gram samples were weighed in duplicate into 9-gram, 50 per cent cream-test bottles and frozen in 30 to 40 minutes in a cold room that was maintained at about – 15° C.

On the second day thereafter these samples were thawed and the stability of their emulsions was determined as described by Webb and Hall (10), except that the fat columns were clarified by leaving the bottles overnight in a room that was maintained at 10° C., instead of 15°, and no control tests were run on the unfrozen samples.

The stability of each emulsion is expressed as the percentage of the total fat in the cream which oiled off in the form of a clear, well-defined fat column after the sample was centrifuged 30 minutes in a Babcock tester at 40° C. The most stable samples showed practically no fat separation. The least stable ones rarely oiled off completely.

The method of van Dam and Sirks (3) as described by Babcock (1) was

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[1] Temperatures reported throughout the manuscript are in °Centigrade.

adapted to the preparation of cream for microscopic examination. One-tenth of a ml. of the cream was diluted with 100 ml. of a solution which consisted of 1.5 parts of gelatin dissolved in 100 parts of water to which phenol was added to make the solution 1 per cent phenol. After this emulsion had been shaken a drop of it was examined in a Levy-Hausser counting chamber under a 15× eyepiece and a 45× objective. The average number of globules in several fields was considered representative for a sample.

Viscosity determinations were made with a MacMichael viscosimeter.

It seemed obvious that the fat globules in heavy cream, being more closely packed than in light cream and less protected by proteins, would oil off more than the fat globules in light cream. Therefore, experiments were conducted to determine the concentration of fat which would be likely to disclose to advantage the influence of various factors on oiling off of the thawed cream. Cream of 40 per cent fat content was chosen.

EXPERIMENTAL RESULTS

Influence of globule size in milks upon the stability of the fat emulsion of their creams after freezing. The data in table 1 show that the number of fat globules in 40 per cent cream was greater in the cream from Holstein milk than in that from Jersey milk, even when the fat content of the milks was about the same. In the pasteurized creams of August 8, 9, 10, and 17, the number of globules per field in the Holstein creams was 139, 153, 136, and 130, respectively; and in the Jersey creams the number was 113, 122, 94, and 101, respectively. The average difference per field for the 4 days was 32 globules, or 30 per cent more globules in the Holstein creams than in the Jersey creams. The difference in the fat content of the milks on any one of these 4 days did not exceed 0.3 per cent.

TABLE 1

Relative number of fat globules in 40-per cent cream from Holstein milk and from Jersey milk

Date 1944	Holstein milk			Jersey milk		
	Fat in milk	Raw cream	Pasteurized cream	Fat in milk	Raw cream	Pasteurized cream
	%	*No. of globules*	*No. of globules*	%	*No. of globules*	*No. of globules*
6/27	3.2	.....	166	5.0	.....	80
7/5	3.0	.....	205	4.4	.....	95
7/7	3.0	162	153	5.4	87	89
7/17	3.3	190	.....	4.4	136	.....
8/8	3.5	.....	139	3.7	.....	113
8/9	3.7	.....	153	4.0	.....	122
8/10	3.6	.....	136	3.9	.....	94
8/17	4.1	139	130	4.3	101	101
8/30	.....	.....	.....	5.0	87	86
9/1	3.3	190	210	.....	.....	.....

The ratio of the diameters of the Jersey and Holstein fat globules drawn by Eckles and Shaw (4) is very nearly as 1.26 : 1.

TABLE 2

Effect of size of fat globules on the stability of the fat emulsion of raw and pasteurized 40-per cent cream after freezing, brief storage and thawing. Fresh milk was not cooled and was separated at 33° to 37° C. Cream was pasteurized by heating to 80° and cooling without holding to not lower than 30°

Date 1944	Breed	Fat in milk	Description of cream	Oiling off of cream after freezing and thawing
		%		%
7/7	Holstein	3.0	Raw	2
			Pasteurized	2
	Jersey	5.4	Raw	12
			Pasteurized	59
7/10	Holstein	3.2	Raw	2
			Pasteurized	2
	Jersey	4.6	Raw	15
			Pasteurized	65
	50% Holstein and 50% Jersey milk	3.9	Raw	4
			Pasteurized	37
7/17	Holstein	3.3	Raw	1
			Pasteurized	1
	Jersey	4.4	Raw	9
			Pasteurized	45
	Holstein cream Jersey skim	4.2	Raw	2
			Pasteurized	2
	Jersey cream Holstein skim	3.4	Raw	23
			Pasteurized	46
7/22	Holstein	3.2	Raw	3
			Pasteurized	6
	Jersey	4.4	Raw	35
			Pasteurized	65
8/8	Holstein	3.5	Raw	1
			Pasteurized	2
	Jersey	3.7	Raw	2
			Pasteurized	15
8/10	Holstein	3.6	Raw	5
			Pasteurized	7
	Jersey	3.9	Raw	32
			Pasteurized	46
8/17	Holstein	4.1	Raw	2
			Pasteurized	9
	Jersey	4.3	Raw	5
			Pasteurized	19

Gutzeit (5) gives the average diameter of the Jersey fat globules in his investigations as 3.50 microns. If we accept this figure, then, on the basis of the ratio 1.26 : 1, the average diameter of Holstein globules is 2.77 microns.

Since the volume of a sphere is equal to 0.5236 (diameter)^3, the volume of a Jersey globule of average size is 22.45 cubic microns and that of a Holstein globule is 11.13 cubic microns. Therefore, in two creams of the same fat content, one from milk representative of the Jersey breed and the other from milk representative of the Holstein breed, the latter should contain twice as many fat globules as the former.

TABLE 3

Influence of cooling the milk and of the separating temperature upon the stability of the fat emulsion of 40-per cent raw and pasteurized creams as measured by the per cent oiling off after freezing. Cream was heated to 80° C. and cooled without holding to not less than 30° before sampling for freezing

Date 1944	Fat in milk	Description of cream	Uncooled milk separated at 37° C.	Cooled milk separated at 25° C.	Cooled milk separated at 37° C.
			Oiling off of cream after freezing and thawing		
	%		%	%	%
5/31	3.5	Raw	6	47	24
		Pasteurized	6	27	40
6/17	3.1	Raw	2	29	25
		Pasteurized	2	15	60
8/28	3.3	Raw	2	8	6
		Pasteurized	3	5	16
8/30	5.0	Raw	5	80	15
		Pasteurized	17	84	46
8/31	3.8	Raw	2	25	10
		Pasteurized	5	10	21
9/12	3.5	Raw	2	42	8
		Pasteurized	2	8	17
9/14	4.6	Raw	6	62	29
		Pasteurized	9	73	56
11/21	4.3	Raw	3	52	28
		Pasteurized	5	55	56

The morning milks referred to in table 2 were warmed at Beltsville to 43° C., with a moderate amount of agitation, and separated in the Washington Laboratory at the temperature (33° to 37° C.) at which they were received.

As soon as the standardized raw and pasteurized 40-per cent creams were available, 9-gram samples were weighed in duplicate into cream-test bottles and frozen. At no time before the samples were placed in the hardening room was the milk or cream below 30° C. The interval between milking and freezing did not exceed 6 hours.

Less oiling off occurred in cream from Holstein milk than in cream from Jersey milk and, except when the samples were of equally high stability, in

raw cream than in pasteurized cream. The oiling off figures for cream prepared from equal parts of the Holstein and Jersey milks obtained July 10 demonstrate especially well the effect of the breed source of the fat, and the same is true of the oiling off figures for the creams of July 17 that were prepared from Holstein cream and Jersey skim milk, or vice versa.

Influence of cooling the milk and of the separating temperature on the stability of the fat emulsion of cream after freezing. Warm morning milk was mixed and divided into two portions. One portion was cooled to 10° C., the other was warmed to 43°, and both portions were then sent to Washington. On arrival, the warmed portion was separated without delay; half of the cooled portion was warmed to 25° and half to 37° before separation. Each of the three creams was standardized with its own skim milk to 40 per cent fat content. Oiling-off results are presented in table 3.

In every instance cream from milk that had not been cooled was more resistant to the destabilizing forces of freezing, holding, and thawing than was cream from milk that had been cooled.

Samples of raw cream from cooled milk that was separated cold oiled off more than did those from cooled milk that was separated warm. However, after these creams were pasteurized, those from the former milks were the more stable except when the fat content of the milk was high.

These results would seem to be in at least partial agreement with those of Hening (6). Hening found that cream separated from milk held cold oiled off less when it was frozen, thawed, and heated than cream separated in the regular manner. A direct comparison cannot be made because of differences in procedure.

Influence of the temperature and time of holding of the cream before freezing on the stability of the emulsion. It has been shown that the temperature at which the milk was maintained and the temperature of the milk when separated were important factors in determining the resistance of the cream to the destabilizing forces of freezing. As will be shown by data in table 4, the temperature and age of the cream prior to the time the samples were placed in the hardening room also affected to a large degree the percentage of oiling off. This was true regardless of whether the separating temperature was 25° or 37° C.

The samples were cooled from 30° C. to 15°, 10°, and 5° by pouring 200-ml. portions of each pasteurized cream into a suitable flask, partially immersing the flask in ice water, and stirring moderately.

The data in table 4 are not to be interpreted rigidly. In other experiments of comparable design the oiling off figures, while of different magnitude, showed the same general effects of the various factors. The emulsion stability of creams made on different dates as measured by "oiling off" values depended to a large extent upon the properties of the milk when it was separated.

TABLE 4

Influence of the cream holding temperature before freezing upon the stability of the emulsion of thawed 40-per cent cream. Temperature of the mixed night milk when received 4° C. Each cream was heated at 61° for 30 minutes before cooling it to the holding temperature

Description of cream	Oiling off of cream when milk separating temperature was	
	25° C.	37° C.
	%	%
Fresh raw cream at 30° C.	12	8
Raw cream held 4 hours at 30° C.	13	15
Fresh pasteurized cream at 30° C.	15	20
Pasteurized cream held 4 hours at 30° C.	22	23
" " " " " " 15° C.	50	54
" " " " " " 10° C.	60	75
" " " " " " 5° C.	80	88

According to figure 1, the temperature to which warm cream was cooled in a few seconds over a tubular surface cooler through which brine was flowing, quickly had its effect upon the stability of the emulsion. Only a few minutes were required to weigh the cooled samples in duplicate and to place them in the hardening room.

The degree of clumping of fat globules is greater in cooled than in warm milk (9) and cream (1), and larger fat globules apparently clump more readily than smaller ones (1). The greater viscosity of cooled milk and cream is generally regarded as due primarily to clumping. The time required to temper the pasteurized creams to 20°, 10° and 5° C. and place their 9-gram samples in the hardening room was too brief for clumping (and the consequent changes in viscosity) to have been the cause of the destabilization

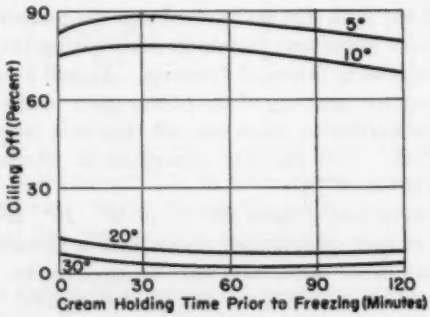

FIG. 1. Influence of the temperature and time of holding 40 per cent cream upon the stability of the emulsion after freezing the cream. Uncooled 4.1 per cent mixed milk was separated at 35° C. Cream was heated to 80° before cooling it to 30°. Portions were then cooled quickly over a surface cooler to 20°, 10° and 5°. Holding temperature is shown on each curve.

of the emulsions, although increased clumping may have been a contributing factor.

Data on the relationship between the viscosity of cream before freezing and the extent of oiling off after freezing are presented in table 5.

TABLE 5

Relationship between the viscosity of cream at 30° prior to freezing and the extent of oiling off after freezing. The fat content of the mixed morning milk was 3.9 per cent. Cream was pasteurized by heating it to 80° C. and cooling without holding

Description of cream	40-per cent cream from uncooled milk separated at 37° C.		40-per cent cream from milk cooled to 10° C. and separated at 25° C.		40-per cent cream from milk cooled to 10° C. and separated at 37° C.	
	Viscosity	Oiled off	Viscosity	Oiled off	Viscosity	Oiled off
	centipoises	%	*centipoises*	%	*centipoises*	%
Fresh raw at 30° C.	15	7	22	60	17	33
Raw held 2 hours at 30° C.	15	6	22	70	17	46
Fresh raw at 10° C.	30	75	63	50	34	96
Raw held 2 hours at 10° C.	33	85	172	71	42	93
Fresh pasteurized at 30° C.	15	10	16	58	16	71
Pasteurized and held 2 hours at 30° C.	14	9	16	63	16	70
Fresh pasteurized at 10° C.	28	77	35	95	33	99
Pasteurized and held 2 hours at 10° C.	32	83	43	95	40	96

DISCUSSION

It is known that rapid freezing of cream is more effective in stabilizing the fat emulsion than slow freezing (8).

In the work reported here it is shown that cooling 40-per cent cream over a surface cooler to 5° and 10° C., prior to placing 9-gram samples in cream-test bottles and freezing them, caused the thawed cream to oil off to a high degree. Since in freezing the 9-gram samples of cream which had not been cooled, the cream passed through this temperature and oiled off only a little after being thawed and centrifuged in the usual manner, it is apparent that the conditions under which the cream reached its freezing point were important.

When placed in the – 15° C. room, 9 grams of 30° cream in a cream-test bottle cooled to 10° in 5 minutes and to – 1° in 10 minutes. When placed in this same room, 400 ml. of 30° cream in a 1-liter flask cooled to 10° in 30 minutes. The flask was shaken only enough to obtain a uniform temperature for an occasional thermometer reading. Nine-gram samples of this 10° cream which were weighed into the test bottles as soon as possible and frozen, oiled off more than did uncooled samples. When the air-cooled cream was maintained at 10° and samples were taken at 15-minute intervals for freez-

ing, the rate of oiling off in samples obtained during the first 30 minutes increased rapidly and then during the next hour more slowly and until the percentage of oiling off approached that of cream of the same source that had been cooled to 10° over the surface cooler. Here again the oiling off values varied with the emulsion stability of the warm pasteurized cream that was used.

Rishoi and Sharp (7) published curves which show the change in volume of milk fat in cream held at 20°, 15°, 10° and 5° C. According to these curves the decrease in volume at 20° is small, at 15° it is large, and at 10° it is more rapid but only slightly greater than at 15°. The curve for 5° is similar to the one for 10°. The position of these curves and of those in figure 1 suggests a relationship between the decrease in volume of the fat at the time of sampling the cream and the amount of oiling off.

Since at 10° C. considerable time is required to liberate the latent heat of fusion of milk fat and change the fat from a liquid to a semisolid, it seems improbable that a change of phase or decrease in volume is the explanation for the excessive oiling off of the cream that was chilled in a few seconds to 5° and 10° over a surface cooler and frozen without delay. If a change of phase is the explanation for the greater oiling off of the cream that was cooled before it was sampled for freezing, then slow cooling to this temperature range would be expected to cause greater oiling off than rapid cooling. That lack of agitation is the reason for the results obtained when the cream was cooled slowly in air is open to question, because cooling 400 ml. of warm cream to 10° in the −15° room with mechanical agitation and with the flask in air or ice water yielded essentially the same oiling off results.

On being warmed to 30° from 10° C., the cream regained at once its original ability to withstand the disruptive forces of freezing and thawing. When the temperature of this rewarmed cream was lowered to 10°, either slowly in the −15° room or quickly over the surface cooler, and samples were frozen and thawed in the usual manner, the cream oiled off less than after the first cooling. Highly stable fresh cream that was cooled a second time and frozen, oiled off relatively little when thawed.

The change in emulsion stability which took place the first time the cream was cooled was reversible. The change which took place the second time the cream was cooled was partially reversible on rewarming the cream.

SUMMARY AND CONCLUSIONS

Raw and pasteurized 40-per cent cream from uncooled Holstein milk oiled off less after brief storage at −15° C. than did raw and pasteurized 40-per cent cream from uncooled Jersey milk.

Similar results were obtained when cream from uncooled milk was compared with cream from milk that was cooled to 10° C. and separated at 25° or 37°.

In general, pasteurized 40-per cent cream oiled off as much as or more than did raw 40-per cent cream after freezing. An exception was pasteurized cream from cooled milk of less than average fat content when separated at a relatively low temperature (25° C.).

Differences in milk, especially in the size and number of the fat globules, and changes in the temperature of the milk and cream, greatly influenced the stability of the cream emulsion measured by the amount of oiling off after freezing and brief storage.

The conditions under which the cream was cooled to its freezing temperature influenced the extent of oiling off after freezing and brief storage.

Cream cooled in a few seconds over a surface cooler to 5° and 10° C. was much less resistant to the destabilizing forces of freezing and brief storage than was cream that was cooled in 10 to 30 minutes with or without moderate agitation and then frozen.

Relationships between the viscosity of cream before freezing and the extent of oiling off after freezing are shown.

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THE EFFECT OF TEMPERATURE OF READING ON THE ACCURACY OF THE BABCOCK TEST FOR FAT IN MILK

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In a previous paper (6), it was concluded that deviation of the density of the fatty materials from the value of 0.9 at the temperature of reading (60° C.) introduced a fundamental error into the Babcock method. The remedy for this condition is to adjust the temperature so that the density of the column of fat is 0.9. The objective of this paper is to establish the temperature of reading that must be used to meet this condition.

The literature on this subject is meager and has been reviewed (2, 6). However, it seems pertinent to repeat that Bailey (1) calculated the density of pure milk fat as 0.9 at 45° C. and Dahlberg (3) found it to be 0.8943 at 55.5° C. which corresponds to 0.9 at 47.4° C.

EXPERIMENTAL

The temperature at which the density of the fatty materials equals 0.9 can be calculated by the following formula:

$$t = \frac{60\,D_{60}C + D_{60} - 0.9}{D_{60}C}$$

where:

t = Temp. (°C.) at which density is 0.9
D_{60} = Density (gms./ml.) at 60° C.
C = Coefficient of expansion (ml./ml./°C.)

The coefficient of expansion of the fatty materials has been shown to average 75.58×10^{-5} ml./ml./°C. (6), and using this value for C and average values for D_{60}, the densities of 0.9 have been calculated for the four series of samples previously reported (6). These computed temperatures are recorded in table 1 with those[4] for purified milk fat. The difference between the two series of temperatures indicates that the fatty materials from the Babcock test have a greater density than the purified fat. The mean temperatures at which the purified fats have a density of 0.9 are in close agreement with Bailey's (1) figure of 45° C. and an average temperature of 53.5° C. satisfies the condition that the density of the fatty materials be 0.9 at reading.

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[3] Published with the approval of the Director.

[4] Using average values for D_{60} and 78.34×10^{-5} ml./ml./°C. for C (6).

TABLE 1

Temperatures at which the densities of Babcock fatty materials and of purified milk fat are 0.9

Sample	Babcock column contents			Purified milk fat		
	No. of samples	Temperature		No. of samples	Temperature	
		Mean	S.D.*		Mean	S.D.*
		°C.	°C.		°C.	°C.
Jersey	46	52.5	5.5	45	44.0	1.8
Holstein	45	53.3	5.4	46	44.4	2.1
Univ. Composite	47	53.5	6.3	47	44.4	1.7
Creamery Composite	46	54.5	6.8	45	43.7	1.9
All Samples	184	53.5	6.0	183	44.1	1.9

* Standard Deviation of single determination.

Since the coefficient of expansion of the fatty materials is 75.58×10^{-5} ml./ml./° C., the Babcock reading would be expected to fluctuate by 0.0007558 per cent/per cent fat/° C. For example, a difference of 20° C. in reading temperatures should produce a difference of 0.06 per cent fat in the test of 4 per cent milk. Caldwell and Herreid (2) had prevoiusly studied the effect of water bath temperatures on the Babcock reading, and the differences they reported are compared, in table 2, with differences calculated from the coefficient of expansion. The fact that the measured differences were smaller than the calculated ones suggested that the fatty materials may not actually attain the temperature of the bath in the allotted time.

In an effort to obtain some information on this point, the rate of rise of temperature of the fatty materials of tests immersed in a water bath at 60° C. was measured, at various levels within the column, with a copper-constantan thermocouple and Leeds and Northrup potentiometer. The results of this study, shown in table 3, reveal that the temperature in the column increases with depth, that it increases slightly with increase in fat percentage of the milk, and that it rapidly becomes established at an equilibrium point below the temperature of the bath. This behavior is unlike

TABLE 2

Comparison of observed and calculated effect of temperature on the Babcock reading

Temp. of bath	No. of samples*	Mean Babcock reading†	Differences due to temperature	
			Observed	Calculated
°C.		*per cent fat*	*per cent fat*	*per cent fat*
37.8	10	4.33		
			0.040	0.071
60.0	10	4.37		
			0.030	0.036
71.1	10	4.40		

* Each sample tested in quadruplicate.
† Data of Caldwell and Herreid (2). These were confirmed in 2 later experiments.

that of fat in a narrow-necked dilatometer (also shown in table 3) wherein the temperature eventually does attain that of the bath.

Finally, an attempt was made to reconcile actual and calculated differences due to temperature of reading. For this purpose three series of experiments were conducted. In series 1, involving 5 samples, readings of

TABLE 3

Temperatures at various depths in columns of Babcock fatty materials in comparison with temperatures in a dilatometer filled with purified milk fat at various times after immersion in a water bath at 60° C.

		Sample								Purified fat in 5 ml. dilatometer
		1	2	3	4	5	6	7	8	
Per cent fat		3.51	3.81	3.59	3.62	3.65	4.63	5.29	3.64	
Length of column (mm.)		30.2	32.8	30.9	31.2	31.5	39.9	45.6	31.4	
Depth of immersion of thermocouple (mm.)		5.6	9.9	14.2	14.2	14.2	14.2	14.2	18.6	
No. of replicate detns.		3	3	4	4	2	3	3	3	
Mean temperature (°C.) after:										
Min.	*Sec.*									
	0	48.2	46.1	44.7	46.1	50.0	46.1	45.4	51.2	30.5
	15	49.8	49.4	46.9	49.5	52.5	52.0	52.4	52.6	
	30	53.4	52.4	52.9	53.4	55.5	54.8	54.7	55.7	42.3
	45	55.2	55.1	55.1	55.7	56.9	56.4	56.4	57.5	
1	0	56.0	56.2	56.4	57.1	57.6	57.2	57.3	58.2	51.2
	15	56.4	56.6	56.9	57.3	57.5	57.6	57.8	58.8	
	30	56.6	56.9	57.1	57.5	57.9	58.0	57.8	58.9	54.5
	45	56.6	57.1	57.2	57.5	57.9	58.0	57.8	59.0	
2	0	56.6	57.1	57.3	57.7	57.9	58.0	57.8	59.0	56.3
	15	56.7	57.0	57.5	57.7	57.9	58.2	57.8	59.0	
	30	56.6	57.0	57.5	57.7	57.9	58.2	57.8	59.0	
	45	56.5	57.5	57.5	57.7	57.9	58.1	58.0	59.0	
3		56.6	56.9	57.5	57.7	57.9	58.1	57.9	59.0	58.2
4		56.3	57.2	57.6	57.7	57.5	57.9	57.8	58.8	59.1
5		56.3	56.9	57.5	57.6	57.9	58.0	57.9	59.0	59.5
10		56.3	56.9	57.5	57.5	57.7	57.7	58.0	58.8	
15		56.3	57.0	57.5	57.5	57.7	57.6	57.9	58.8	60.0
20		56.2	57.1	57.5	57.5	57.6	57.6	57.9	58.8	
25		56.1	56.9	57.5	57.5	57.6	57.6	57.9	58.8	
30		56.1	57.1	57.4	57.5	57.6	57.6	57.9	58.8	

fat column temperatures were compared on replicate tests read directly from the heated centrifuge immediately after centrifuging, from the water bath after 5 minutes and, from the water bath after 10 minutes. In series 2, involving 21 samples, similar determinations were made but a 10-minute holding period in the room was substituted for holding in the water bath for 10 minutes. Series 3, in which 15 samples were employed,

involved a comparison only of reading directly from the heated centrifuge and from the bath after 5 minutes.

The data obtained in these experiments are summarized in table 4. Statistically the differences between the mean readings of tests read directly from the centrifuge and of those held 5 or 10 minutes in the bath are insignificant as would be expected from the slight differences in column tempera-

TABLE 4

Babcock readings and temperatures of the fatty materials under various conditions

Series	No. of samples*	Direct from centrifuge†		Held in bath 5 minutes‡		Held in bath 10 minutes§		Held in room 10 minutes‖	
		Temperature of column before reading							
		Mean	S.D.¶	Mean	S.D.	Mean	S.D.		
		°C.	°C.	°C.	°C.	°C.	°C.		
1	5	50.7	1.8	54.3	1.8	55.4	1.3		
2	21	.....	.....	.....	.....	.....	.....		
3	15	50.7	1.8	55.1	1.4	.....	.....		
		Temperature of column after reading							
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
		°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1	5	45.1	1.3	47.6	1.5	47.9	1.4	.....	.....
2	21	46.9	1.6	48.3	1.3	.....	.....	29.2	3.2
3	15	45.5	1.6	47.4	1.4	.....	.....	.....	.....
All samples	41	46.2	1.7	47.9	1.4	.....	.....	.....	.....
		Babcock reading							
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
		%	%	%	%	%	%	%	%
1	5	3.668	0.562	3.698	0.560	3.678	0.560	.....	.....
2	21	4.270	1.136	4.265	1.144	.....	.....	4.212	1.122
3	15	4.122	0.418	4.123	0.435	.....	.....	.....	.....
All samples	41	4.142	0.892	4.144	0.898	.....	.....	.....	.....

* Babcock readings and temperature determinations were made in quadruplicate on each sample.

† The temperature within the centrifuge averaged 60.2° C. near the periphery and 50.4 °C. at the center.

‡ The temperature of the bath averaged 59.9° C.

§ The temperature of the bath averaged 60.2° C.

‖ The temperature of the room averaged 25.6° C.

¶ Standard deviation of single determination.

tures. In series 2, the difference between readings from the centrifuge and from the room after 10 minutes amounted to 0.058 per cent fat. This difference is highly significant statistically, and furthermore it closely approximates the difference of 0.057 per cent fat calculated from the difference in temperature after reading. Between reading from the bath after 5 minutes and from the room after 10 minutes the difference of 0.053 is highly significant and corresponds closely to the calculated difference of 0.061.

The temperatures of the fat columns held in the bath 5 minutes do not agree as closely as might be expected with those reported in table 3, and it is not known what caused this discrepancy. The decided decrease in column temperature during the 20–30 seconds usually required to make a reading is noteworthy.

DISCUSSION

In a bath at 60° C. the temperature of the Babcock column rises to such a temperature that the density of the column contents is slightly below 0.9. Upon removal of the test from the bath for reading the temperature of the column falls to a point at which the density of the contents is slightly above 0.9. These facts tend to offset the earlier contention that deviation of the density of these materials from a value of 0.9 at 60° C. introduces an error into the Babcock method. Rather it appears that the calculated errors shown in the previous paper (6) represent maxima that would apply were the temperature of the column to attain that of the bath and remain there during reading. On these grounds a bath temperature of 60° C. seems justified. Furthermore, reading directly from the heated electric centrifuge appears equally well justified, since tests read from the centrifuge do not differ significantly from those read from the bath.

SUMMARY AND CONCLUSIONS

An investigation of the fundamental factors underlying the establishment of the proper temperature for reading the Babcock test, indicates that a temperature of about 53.5° C. for the fatty materials fulfills, on the average, the condition that its density be 0.9. This temperature is approximated in tests read after holding for 5 minutes in a water bath at 60° C. as well as in those read directly from the heated electric centrifuge.

Differences in test due to differences in temperature of reading can be accounted for, on the average, by the coefficient of expansion of the column.

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THE MANUFACTURE OF CHEDDAR CHEESE FROM PASTEURIZED MILK IN COMMERCIAL PLANTS

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Research work to develop a controlled method for manufacturing Cheddar cheese from pasteurized milk has been conducted by the Bureau of Dairy Industry for a number of years. After a practical and successful procedure was developed in the laboratory, the method was tried under commercial conditions in factories in Tennessee and other southern States, and later in Oregon, Washington, and Wisconsin. This work demonstrated that, if the milk is of average or somewhat better than average quality and the cheese maker follows the controlled method of manufacture developed in the Bureau, a very high percentage of the cheese will meet U. S. No. 1 specifications.

The procedure recommended for manufacturing Cheddar cheese from pasteurized milk has been described in earlier publications (1, 2). Some of the experimental results obtained in the laboratory, and also results of work done in factories in Wisconsin during 1938 and 1939, have been described in an earlier publication (3) in this journal.

When the United States Government began early in 1942 to purchase Cheddar cheese in large quantities for lend-lease shipments and for the armed forces, a relatively high percentage of the cheese that was offered for purchase was not of U. S. No. 1 grade. In an effort to increase the quantity of No. 1 cheese, the Bureau began a more intensive program of introducing its method by providing assistance in factories that requested help. Arrangements to provide such assistance were usually made through the State extension service or dairy department of the State college. The introductory work was done by specialists of the Bureau who had previously had practical experience in the application of the method. Each specialist usually had a portable, trailer laboratory and traveled from factory to factory. Since early in 1942 the Bureau representatives have worked intensively in factories in Minnesota, Indiana, Missouri, and Arkansas, and less intensively in Illinois, Michigan, Ohio, and Tennessee.

When the introductory work was begun in Minnesota, the specialist spent as much time at each factory as was necessary to establish the method and obtain the grading records. Later, it was found possible to save time and assist more factories by having the specialist spend only enough time at each factory to acquaint the operator with the method and return later to determine the progress made and to render further assistance if necessary. The long time spent at the Minnesota factories made it possible to obtain fairly

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complete data in 11 of the 20 factories in which work was carried on there during a period of 18 months. Partial records of some of the work, particularly after assistance was provided, were obtained in the other States mentioned above.

This paper is a report of the procedures used in the quality improvement work, and of results obtained since the beginning of 1942 in Minnesota, Indiana, Missouri, Arkansas, Ohio and Michigan, where organized programs were carried out.

METHOD OF MANUFACTURING CHEESE

The introductory work consisted essentially of the following:

(A) Grading the milk by means of the methylene blue and sediment tests and suggesting quality improvement procedures, including sanitation, cooling of milk, and rejection of low-grade milk.

(B) Instructing the factory personnel in the preparation, handling, and care of active, uncontaminated, starter cultures; and encouraging the assignment to one individual of definite responsibility for the care of starters.

(C) Checking the effectiveness of the pasteurizer to assure complete pasteurization.

(D) Demonstrating the recommended method of making cheese.

The milk supply. The quality of the milk varied considerably in the different plants and in the different areas. The principal causes for inferior quality of milk were improper and insufficient cooling of the milk and inadequate cleaning of the utensils.

Methylene blue, fermentation, and sediment tests were usually conducted in each plant. In most instances where the quality of the milk was as poor as would be indicated by a No. 4 sediment pad or a methylene blue reduction time of less than ½ hour, the cheese maker tentatively rejected further deliveries of the milk and the plant field man visited the farm to assist the producer in improving the quality. When the milk was definitely of poor quality as indicated by the presence of off-odors, acidity that might render it unsuitable for pasteurization, or visible extraneous matter, it was rejected. Except for such rejections, all milk accepted by the cheesemaker was used. The primary emphasis was placed on effective pasteurization and on the cheese-making procedure.

Starters. Introductory work revealed that the use of defective starters was one of the factors responsible for a considerable proportion of the cheese being No. 2 or undergrade. The most common defects found were contamination and lack of activity sufficient to produce the proper amount of acid and coagulate the milk normally.

In those instances in which the starter was defective or of doubtful quality, a new culture was provided or arrangements were made to obtain a commercial starter, and an adequate program for maintaining it was outlined. For the production of a satisfactory starter, consideration was given to the following factors:

1) Incubators, and steamers for mother-starter milk and transfer pipettes were inspected.

2) The equipment was required to be thoroughly clean and practically sterile.

3) Mother-starter milk and batch milk were heated to between 190° and 200° F. and held at that temperature for at least 1 hour.

4) The starter milk was cooled to 70° F., held at that temperature until it was inoculated, and incubated at that temperature.

5) Carefully adjusted (usually smaller) inoculations of mother culture into both the new mother-starter milk and the bulk-starter milk were made, so that the acidity of the mother culture would be about 0.7 to 0.8 per cent after it had been incubated and cooled and was ready for the next transfer, and the acidity of the bulk starter would also have this value 14 to 17 hours after inoculation.

6) After incubation and coagulation, the mother culture was cooled to as low a temperature as possible, preferably between 32° and 40° F. if conditions permitted, until ready for use; the batch starter was cooled, preferably to 50° F. or lower if conditions permitted, as soon as about 0.65 per cent acidity had developed.

Active, uncontaminated starters, maintained under controlled conditions and used in carefully regulated amounts, produced approximately the proper amount of acid uniformly during the controlled making process. Unsatisfactory starters, usually either inactive or contaminated, produced very little acid during the making process, and under such conditions it was not uncommon for gas to develop in the curd in the vat and also after the cheese was made.

Pasteurization. Pasteurization has proved to be a means of improving the quality and uniformity of the cheese considerably and of making it easier to control the manufacturing process. It is essential that all of the milk in any lot be pasteurized properly if the product is to be designated as "pasteurized milk cheese." As defined by the U. S. Public Health Service, pasteurization refers to "the process of heating every particle of milk to at least 143° F. and holding at such temperature for at least 30 minutes, or to at least 160° F. and holding at such temperature for at least 15 seconds, in approved and properly operated equipment: Provided, that nothing contained in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient and is approved by the State health authority."

The pasteurizing temperature recommended in our introductory work was 161° to 162° F., which provided a margin of safety of 1° or 2° above the Public Health Service standard. Attempts were made to attain a holding period of 15 seconds. The pasteurizer in each plant was checked repeatedly to assure pasteurization of all the milk, and the effectiveness of pasteur-

ization was determined by conducting the Scharer phosphatase test on a sample from each vat. In each instance in which the phosphatase test was positive, necessary adjustments of the pasteurizer or of its operation were made. These included installation or adjustment of the heat regulator, installation of a holding pipe of appropriate dimensions, and, in some instances, installation of a manually adjustable, 3-way, by-pass valve at the outlet of the holding pipe.

Controlled method of manufacturing cheese from pasteurized milk. Since the recommended procedure has been described elsewhere (1, 2), only the details that contribute additional information or pertain to these results will be mentioned here.

The amount of starter used varied, usually between 0.5 and 1 per cent, only enough being added to produce approximately 0.5 per cent acidity in the

TABLE 1

*Time schedule and average temperatures, titratable acidities, and pH values, for 350 lots of pasteurized-milk cheese of U. S. No. 1 grade**

Operation	Time from setting	Temperature	Acidity	pH value
	hr.: min.	*°F.*	*%*	
Rennet added	0: 00	88	0.175	.....
Cutting	0: 30	.....	0.117	6.40
Steam on	0: 45	.....	.....	.....
Steam off	1: 15	100	.....	.....
Dipping	2: 15	.....	0.149	6.15
Packing	2: 35	.....	0.194	.....
Milling	4: 30	95	0.479	5.38
Salting	4: 45	92	.....	.....
Hooping	5: 15	89	.....	.....
Pressing	5: 30	.....	.....	.....
Dressing	6: 00	.....	.....	.....

* Milk pasteurized at 162° F. for 15 seconds; 0.5 to 1.0 per cent starter; average acidity of starter, 0.77 per cent; one hour ripening time after addition of starter; 3 oz. rennet and 3 lb. salt used per 1,000 lb. milk.

whey at milling. A time schedule was followed, which allowed 2¼ hours from setting to dipping and 2¼ hours from dipping to milling—a total of 4½ hours from setting to milling.

The quantity of rennet added (table 1) produced curd that was usually sufficiently firm to be cut after 30 minutes. It was cut evenly and uniformly with ¼- or ⅜-inch curd knives.

Heating was begun 15 minutes after cutting, and care was taken to increase the temperature at a uniform rate during a 30-minute heating period. The cooking temperature was usually 100° F., but in some instances a temperature as low as 98° F. or as high as 102° F. was used, the adjustment of the cooking temperature being determined by the rate of acid development, the firmness of the curd, and the moisture content desired in the finished cheese. Experiments have shown that higher temperatures retard

acid development and hinder proper firming of the curd. The firmness of the curd depends on the temperature and on the rate of development of acidity in the whey rather than on conditions after milling.

Draining, or dipping, the whey was begun, and the acidity of the whey was determined, exactly 2¼ hours after setting. When the whey was drained, ditching was completed and the curd was trimmed and packed, usually about 7 to 8 inches deep. The acidity of the whey was determined as soon as the curd had matted sufficiently to be cut and turned without breaking it, usually 20 minutes after dipping. The curd was cut into blocks, usually about 5 to 6 inches wide, but 8 to 9 inches wide if the acidity was developing too slowly, and 3 to 4 inches wide if the acidity was developing too rapidly.

Each block was given a half turn immediately after cutting. At the next turning, 10 minutes later, the blocks were given a quarter turn and the ends of every other block were reversed. The blocks were given a half turn 10 minutes later; a quarter turn, with the rough side down, 10 minutes later; and a half turn approximately every 10 minutes until 1 hour before milling. They were piled two deep and turned every 10 minutes for the next half hour, and then piled three deep and turned every 10 minutes until milling.

The blocks were kept tight against the wall of the vat and against each other. The vat cover was kept on between turnings. Usually steam was admitted at each turning to keep the bottom of the vat warm and the temperature of the curd above 95° F. but not higher than the cooking temperature.

At the time of milling, 4½ hours after setting, and with the proper development of acidity, the curd was well matted and was becoming smooth and meaty. If the acidity of the whey at milling was very much above or below 0.5 per cent, the amount of starter to be used thereafter was altered accordingly. The curd was milled and mixed well, and the salt was added in three portions and mixed in thoroughly after each addition. The curd was hooped and pressed as soon as the salt had dissolved completely.

RESULTS OF WORK IN COMMERCIAL PLANTS

Time schedule, temperatures, and acidities. The time schedule and the average temperatures, titratable acidities, pH values, and other details for 350 lots of U. S. No. 1 cheese made from pasteurized milk in commercial plants are shown in table 1. The data illustrate conditions under which the best cheese was made. The quality and uniformity of cheese made from pasteurized milk were much improved by following a definite time schedule and, in addition, the cheese-making operations were simplified greatly by the use of the time schedule.

The titratable acidities of the milks at setting varied from 0.15 to 0.26 per cent. The acidities at later stages varied to some extent depending on the initial acidity of the milk, but were much more uniform with pasteurized milk than when raw milk was used for cheese making.

Relationship between milling acidity and quality of cheese. In order to determine if there was a relationship between acid development and the quality of the cheese, as had been noted previously (3), the titratable acidity of the whey at milling was compared with the quality of the cheese made from each lot of milk. Data for 579 vats of cheese made from pasteurized milk by the B. D. I. method in numerous factories while the method was being introduced are given in figure 1. With a uniform time interval of $4\frac{1}{2}$ hours from setting to milling, the highest proportion of U. S. No. 1 cheese occurred in those instances where the titratable acidity of the whey at milling was between 0.46 and 0.50 per cent (average pH of the curd, 5.39). The

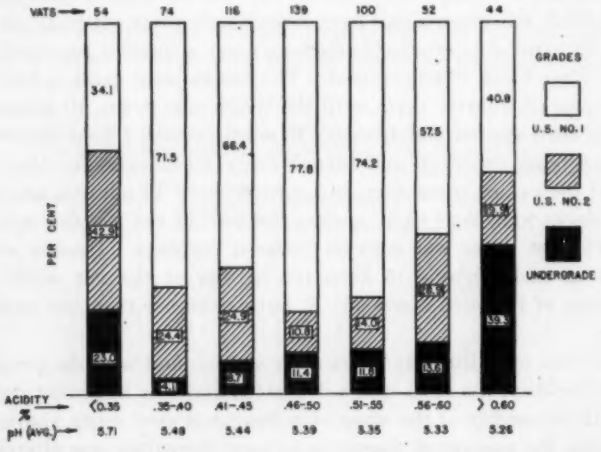

FIG. 1. The relationship of the titratable acidity of Cheddar cheese whey at milling to the average pH value of the curd and to the grade of the cheese.

proportion of No. 1 cheese was much less when the milling acidity was less than 0.35 per cent or higher than 0.55 per cent than when the acidity was 0.46 to 0.50 per cent. When the milling acidity was either comparatively low or comparatively high, most of the cheese usually graded No. 2 or undergrade, because of defects in both body and flavor.

In the group in which the milling acidity was 0.35 to 0.40 per cent (average pH 5.48) in figure 1, the proportion of No. 1 cheese was larger than is to be expected with such low acidity. Apparently this was because of the exceptionally high quality of the milk received at one factory in which a large proportion of the cheese in this acidity group was made.

These data, grouped on the basis of titratable acidities, are substantially in agreement with the results of the preliminary, experimental work described earlier (3), in which the larger proportion of good cheese was obtained when the pH values at milling were between 5.3 and 5.6 and a narrower range of

5.4 to 5.5 was found to be even more desirable. In this more recent work, which was done entirely in factories, the larger proportion of good cheese was obtained when the pH values were between 5.3 and 5.5, and a narrower range of approximately 5.35 to 5.45 was found to be preferable. These correlations between acidities and grades are the basis for proper control of the development of acidity.

Quality of cheese. Data on the quality of cheese made in 11 factories in Minnesota, showing the percentages of cheese of each grade produced in each factory during 1 month before assistance and 2 months after assistance in 1942 and during a period of 8 months in 1943, are presented in figure 2. The data are based on production of approximately 700,000 pounds of cheese per month in these factories at the time when assistance was provided and 3,250,000 pounds during the 8-month period of 1943.

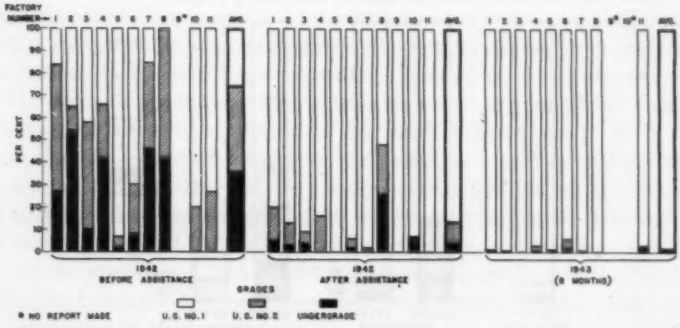

FIG. 2. Percentages of Cheddar cheese of each grade produced in 11 factories in Minnesota, before and after assistance in 1942 and during an 8-month period in 1943.

Wide variations were found at the different factories in manufacturing conditions, including the quality of the milk and of the starters and the cheese-making methods, and these variations were reflected in generally corresponding variations in the quality of the cheese that each factory produced. It will be noted that in some of the factories, *e.g.*, Nos. 1, 2, 3, 4, 7, and 8, indicated in figure 2, only a small proportion (0 to 42 per cent) of No. 1 cheese was being produced before the method was introduced. The factories in which the quality had been lowest before assistance showed the greatest improvement, the proportion of No. 1 cheese increasing in nearly all of them, soon after assistance, to more than 80 per cent. The quality of the cheese made in these factories continued to improve after the end of the period during which the method was introduced; during an 8-month period in 1943, when the method had been in use fully for several months and the amount of assistance by the field man was at a minimum, each of these factories produced at least 96 per cent and two of them produced 100 per cent No. 1 cheese.

Other factories, *e.g.*, Nos. 5, 10, and 11 were producing more than 70 per cent No. 1 cheese before assistance. In two of these the proportion of No. 1 cheese was increased to 100 per cent and in the third it was increased to 92 per cent, during the transition period. The quality of the cheese not only was improved greatly after the introduction of the method, but also was much more uniform than before.

In 1942, before assistance, the proportion of No. 1 cheese produced in these 11 factories varied from 0 to 92 per cent, but only 25 per cent of all the cheese was of the No. 1 grade. Immediately following assistance, the quality was so improved that the proportion of No. 1 cheese produced in these factories varied from 52 to 100 per cent and 86 per cent of all the cheese was of the No. 1 grade. During the 8-month period in 1943 (figure 2) the proportion of No. 1 cheese in these factories varied from 94 to 100 per cent, and 99 per cent of all the cheese was of the No. 1 grade.

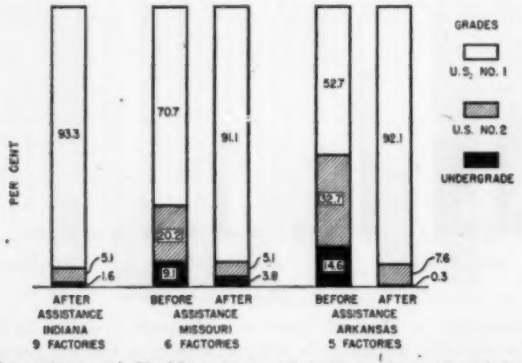

FIG. 3. Percentages of Cheddar cheese of each grade produced in 9 factories in Indiana after assistance, and in 6 factories in Missouri and 5 factories in Arkansas before and after assistance.

The high level of quality and uniformity in the different factories, during the 8-month period in 1943, was attained after the introductory work had been completed and all the details of the controlled method had been put effectively into operation.

The percentage of cheese of each grade produced in 9 factories in Indiana in 1943, after the introduction of this method, is shown in figure 3. The data are based on production of 907,000 pounds of cheese per month in these 9 factories, after assistance. The large proportion of No. 1 cheese and also the uniformity of quality in these factories after assistance was comparable with that shown above, but complete data on the quality before assistance were not available. Introductory work was done also in 13 other factories in Indiana, but complete records are not available.

Data on the quality of the cheese made in 6 factories in Missouri, showing

the percentage of cheese of each grade produced in these factories during 6 months before and 3 months after assistance, are also shown in figure 3. The data are based on production of 370,000 pounds of cheese per month before assistance and 470,000 pounds per month after assistance. The method was introduced also in 32 other factories in that State, but quality improvement data sufficiently complete for tabulation are not available.

The percentage of cheese of each grade produced in 5 factories in Arkansas during 1 month before and 1 month after assistance is also shown in figure 3. These data are based on production of 600,000 pounds of cheese per month. Introductory work was done also in 6 other factories in that State, but complete data on the improvement in quality are not available.

In the cooperating factories from which production and quality records were obtained, in each of the three last-named States, the average proportion of No. 1 cheese produced during the periods of the records, after assistance, was higher than 90 per cent. In the factories for which complete records of quality improvement are not available, the factory managers in general have reported an appreciable improvement in the quality of the cheese.

The examples of improvement given above are typical of the results that have been obtained in the factories that have adopted the B. D. I. method. These include factories in most of the principal cheese-producing areas in the United States. During the period covered by this report, the method was introduced by the Bureau's field men in approximately 150 factories in the States mentioned. However, numerous other factories have adopted the method, in some cases with slight modifications, and hence the factories in which the Bureau's field men have introduced the method do not constitute the total number that are now using it.

The results of the introductory work show that, in all the factories in which the B. D. I. method was used and for which we have records, a large percentage of the cheese was of such quality as to grade U. S. No. 1 and stand up in storage for many months. Moreover, the improvement obtained under a wide variety of conditions indicates that the use of the method will produce equally favorable improvement in any factory or area.

SUMMARY

A method developed in the laboratories of the Bureau of Dairy Industry for making Cheddar cheese from pasteurized milk, for which preliminary results were given in an earlier publication in this journal, has been put into commercial practice in approximately 150 factories.

Results obtained over a period of about 3 years are presented for factories in Minnesota, Indiana, Missouri, and Arkansas, in which the work was carried on intensively and in which practically complete cheese-grading records were available for the periods before and after the method was introduced. Results obtained in factories in Illinois, Michigan, Ohio, and Ten-

nessee, in which less complete grading records were available, are not given in this report.

In those factories in which the proportion of No. 1 cheese had been relatively low, the use of the method resulted in a striking improvement in quality and uniformity. Even in those factories in which the proportion of No. 1 cheese had been relatively high, some improvement in quality and uniformity was obtained.

This work has demonstrated that a uniformly high percentage of No. 1 cheese can be made from pasteurized milk with the use of a suitably controlled amount of an active starter and with the use of a definite time schedule, and that the use of a time schedule simplifies the cheese-making operations.

These results are in agreement with those of the earlier work, in that they indicate a definite relationship between the rate of development of acidity during the making process and the quality of the cheese made from pasteurized milk. They also show the range within which the acidity should be maintained in a controlled making process.

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EFFECT OF INBREEDING ON THE GROWTH CURVES OF HEIGHT AT WITHERS, WEIGHT, AND HEART GIRTH OF HOLSTEIN FEMALES

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Bartlett, Reece, and Lepard (5) suggest that inbreeding may or may not influence the size and development of dairy cattle. Any such effects are likely to be small, especially for low coefficients of inbreeding as defined and used by Wright (8). Thus the superficial application of the usual statistical tests may often overlook significant differences even though they exist; "errors of the second kind" as defined by Neyman (7) will often be made. Even under the best conditions, the effects of inbreeding tend to be obscured by other genetic differences between groups; pregnancy; differences in climate, environment, and rations; random sampling variations; erratic fluctuations, especially in weight; differential mortality due to accidents and epidemics; and similar factors.

This paper will present data, with their mathematical and statistical analyses, for one bull, Bear Valley Ormsby Esther 518683. Since he was the only Holstein bull used in the University herd for a period of 13 years, a considerable degree of inbreeding was attained. He died March 26, 1941. In order to deal adequately with these data, it was necessary first to develop and adapt methods of analysis.

DATA

The data consist of measurements on 88 daughters of this bull: 24 outcrossed, $F = 0$ (F being the coefficient of inbreeding); 8 with $F = 12.50$; 27 with $F = 25.00$; 10 with $F = 31.25$; 13 with $F = 37.50$; 6 with an average $F = 41.66$. Monthly measurements were made on height at withers (hereafter referred to as height), live weight, and heart girth from birth until death, except that later in the experiment the measurements did not start until an age of about 6 months. Some monthly measurements were skipped throughout the experiment. Because of a lack of help, measurements have been omitted more frequently since the beginning of World War II.

We shall deal with the average growth curves of those animals, so that only the females whose records run over a considerable period will be considered. The number included for each F category are as follows: $F = 0$, 17 out of 24; $F = 12.50$, 7 out of 8; $F = 25.00$, 14 out of 27; $F = 31.25$, 10 out of 10; $F = 37.50$, 9 out of 13; and $F = 41.66$, 6 out of 6.

The negative per cents of decrease for weight and heart girth for the $F = 25.00$ group given in table 2 indicate that the females retained in this group were heavier and had greater heart girths on the average than did the

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outcrossed females. In this group, however, several died at an age of less than 4 months: 4 died of scours, 1 of navel infection, and 3 of pneumonia. If it is assumed that these losses were primarily small, narrow-chested animals then the observed averages for this group are too high and there has been distortion due to selective mortality. For this reason the females with $F = 25.00$ are omitted in computing the average effect of inbreeding on decrease in size and in making the corresponding tests of significance. Culling was less severe in the last group than in the others, but little difference would result from omitting 1 or 2 more animals.

The other females omitted because of death from sickness and accident were so distributed as not to distort seriously any other F category.

These animals were kept under fairly uniform and adequate conditions of dairy-herd management.

TREATMENT OF DATA

Because the weight data were the most troublesome to deal with, methods adequate for this measurement were developed. For the sake of uniformity they were applied to the other measurements also. The averages as computed from the monthly weights were somewhat rough because of errors of measurements; failure to weigh all animals every month; dissimilarity of fill; variations in the stages of pregnancy cycles; and the usual oscillatory variations in the weights of dairy cattle, as discussed by Baker and Mead (4) and by Baker and Guilbert (3).

For these reasons the observed monthly averages were given a mild smoothing, a 5-month moving average being applied to the data up to 21 months of age, and a 13-month moving average being used at later ages. The latter average was chosen because the average period between calvings was 12 to 13 months. Thus the pregnancy cycle would be largely eliminated by a moving average of this number of terms. The monthly weights so obtained are the "observed" weights in table 1. Weights at 3-month intervals beginning with 6 months of age for the $F = 0$ category were then further smoothed by a mathematical method discussed in previous papers (1, 2). Table 1 gives results of these several methods, applied to all three measurements for the $F = 0$ category.

The application of factors to the growth curves for the $F = 0$ category gave very good representations of the growth curves for the other categories. The factors are computed as the anti-logarithms of the mean difference between logarithms of the mathematically smoothed $F = 0$ measurements and logarithms of the "observed" measurements for the other categories at the ages of 18, 21, 24, 27, 30, and 33 months. The data for one or more of the categories were meager for ages outside these limits.

The per cents considered in table 2 are $100 \times (1 -$ factor applied to the mathematically smoothed $F = 0$ category to obtain the growth curves for

TABLE 1

*Comparison of average heights, weights, and heart girths of outcrossed ($F = 0$) daughters of Bear Valley Ormsby Esther 518683 with values obtained by smoothing with mathematical formulas**

Age (t)	Height		Weight		Heart girth	
	Observed	Smoothed	Observed	Smoothed	Observed	Smoothed
months	*cm.*	*cm.*	*pounds*	*pounds*	*cm.*	*cm.*
6	99	99.0	366	366	116	116.0
9	109	109.0	532	531	134	133.8
12	116	116.1	676	669	148	147.3
15	121	121.2	796	789	157	157.6
18	125	125.0	895	896	165	165.4
21	128	127.9	993	990	172	171.3
24	130	130.2	1086	1071	177	175.8
27	132	132.0	1152	1138	181	179.3
30	135	133.5	1200	1190	184	182.0
33	135	134.8	1236	1228	185	184.1
36	136	135.9	1253	1256	186	185.7
39	137	136.9	1274	1278	187	187.0
42	137	137.8	1294	1297	188	188.0
45	138	138.6	1311	1314	189	188.8

* The observed values are obtained by smoothing the original average monthly measurements with a 5-month moving average to 21 months of age and then using a 13-month moving average to remove the effect of pregnancy for the subsequent values. The average period between calvings was 12 to 13 months. All data were treated the same, although less smoothing may have sufficed for height and heart girth. The heights were further smoothed by the formula $y_{t+1}/y_t = (0.2115t + 30.6557)/(-0.7885t + 44.3909)$ for the first derivative of the height-growth curve. The similar formula for weight is $y_{t+1}/y_t = (t^3 - 17.3657t^2 + 80.0373t + 5.0435)/(t^3 - 17.3657t^2 + 80.4647t + 18.5981)$. For heart girth it is $y_{t+1}/y_t = (-2.8470t + 48.6669)/(-3.8470t + 64.3127)$.

other categories) and hence give the per cent decrease in size with the outcrossed daughters as a base. Upon inspection, the per cents in table 2 appear to be roughly proportional to the coefficient of inbreeding. Deming (6) has discussed least-square fitting in such cases. Employing his method we find these statistically significant factors: first, a factor of proportionality for regression of per cent decrease in height on coefficient of inbreeding of

TABLE 2

Observed and theoretical per cents of decrease in size of height, weight, and heart girth of higher F categories based on size of outcrossed daughters of Bear Valley Ormsby Esther 518683

Number of daughters	Coefficient of inbreeding (F)	Height		Weight		Heart girth	
		Observed decrease	Smoothed decrease	Observed decrease	Smoothed decrease	Observed decrease	Smoothed decrease
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
7	12.50	0.94	1.07	0.19	1.54	0.35	0.38
14	25.00	0.94	.....	−0.35	.....	−0.85	.....
10	31.25	2.08	2.68	1.17	3.86	0.63	0.95
9	37.50	4.64	3.22	7.08	4.63	1.48	1.14
6	41.66	2.46	3.58	5.68	5.15	1.20	1.26

0.0858603 ($P = 0.015$); second, a factor of proportionality of 0.1235382 for regression of per cent decrease of weight on inbreeding ($P = 0.045$); third, a factor of proportionality of 0.0302677 for regression of per cent decrease of heart girth on coefficient of inbreeding ($P = 0.0007$).

The test of significance is obtained by computing a Snedecor-F with 1 degree of freedom for the factor of proportionality (or regression of the per cents of table 2 on coefficient of inbreeding) and with 3 degrees of freedom for residual variation or deviations of the observed per cents from the theoretical proportional values. That is, we test the hypothesis that weight, height, and heart girth do not decrease as the coefficient of inbreeding increases.

SUMMARY

By means of suitable mathematical and statistical techniques we have demonstrated a significant, proportionate per cent decrease of size in height, weight, and heart girth among the daughters of Bear Valley Ormsby Esther 518683 with increasing coefficient of inbreeding.

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SUBSTANCES ADSORBED ON THE FAT GLOBULES IN CREAM AND THEIR RELATION TO CHURNING. V. COMPOSITION OF THE "MEMBRANE" AND DISTRIBUTION OF THE ADSORBED SUBSTANCES IN CHURNING[1]

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Previous papers in this series (11, 12, 14, 18, 19) have shown that at least part of the stability of the emulsion of fat in milk may be attributed to an adsorption "membrane" so tenaciously held at the fat surface as to resist removal by a process of repeated dilution and separation. This "membrane" was found to contain a protein (12), not identifiable with the other proteins of milk (14, 19), and a mixture of phospholipides (12). A high-melting phosphorus-free glyceride was found in "membrane" preparations (12), but its relation to the other components was not established. Rimpila and Palmer (14) found considerable variation in the percentages of protein and phospholipide in the "membrane" from various samples of natural cream, although for any one sample, the amounts and proportions of these adsorbed materials remained relatively constant from the fourth through at least the tenth washing.

Palmer and Wiese (12) observed that when washed cream is churned, the adsorbed materials become divided between the buttermilk and the butter. Their data did not permit a statement as to the quantitative division of these materials upon churning washed creams. However, the experiments of Sandelin (15) on creams consisting of butterfat emulsified in soap or lecithin sols, showed that the stabilizing material is divided in such a way upon churning that it is more concentrated in the butter than in the buttermilk. That a similar division may occur on churning washed cream is indicated by the observation of Powell (see Palmer (10)) that butter serum from washed cream is a more effective depressant of interfacial tension than is the free buttermilk from washed cream. These results may be interpreted as indicating a higher ratio of phospholipide to protein in the butter serum, particularly in view of the contention of Maĭmistova (8) that the capillary activity of the fat globule "membrane" depends on its phospholipide content.

The work reported in the present paper was undertaken to determine

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some of the factors that affect the composition of the "membrane," and to secure quantitative data on the partition of its constituents upon churning.

METHODS

The methods employed for washing cream and analyzing for "membrane" constituents were essentially those pioneered by Wiese and Palmer (12, 18) and Rimpila and Palmer (14), but sufficient modifications in detail were introduced to warrant a brief description of the procedure finally adopted and used throughout this work.

Cream washing. Fresh milk was obtained from the morning's milking of cows in the University herds. Since its temperature was usually 24–27° C. when it reached the laboratory, it was warmed to 40–43° C. in a water bath before separation. The cream was standardized to 30 or 35 per cent fat with its own skim milk before washing. Every cream reported herein was washed six times at 43–46° C. using a Sharples supercentrifuge geared down to about 13,000 r.p.m. The volume of wash water was maintained at approximately 13 times that of the fat (equivalent to 4 volumes water to 1 volume of 30 per cent cream) for each dilution.

Preparation of "membrane" concentrates. The washed cream was standardized to either 30 or 35 per cent fat with distilled water, cooled to 4° C., and held overnight. It was churned at 7–10° C. in two-quart Dazey glass churns operated in a battery in a water bath. The buttermilk was collected and augmented slightly with distilled water rinsings from the butter granules. The butter serum was obtained by melting the butter at 55° C., pouring off as much fat as possible, and centrifuging off the remainder in plastic tubes. Considerable difficulty was experienced in finding a method for separating the butter serum from fat after centrifuging. The procedure finally adopted consisted of solidifying the fat layer and pulling it out with a corkscrew after warming the tube slightly. The layer of "membrane" material adhering to the fat plug was easily removed with a spatula and recombined with the bulk of the serum.

Concentration of buttermilk or butter serum was accomplished by either (1) pervaporation in Visking sausage casings, or (2) acidification to pH 4.0 with glacial acetic acid followed by settling at 0–5° C. overnight.[3] In some cases the latter process had to be followed by centrifuging to attain the desired degree of concentration. The concentrates were dried, when desired, from the frozen state in a vacuum chamber containing alumina.

Analytical methods. In some of the washed creams, lipide phosphorus was determined by the method of Wiese, Nair, and Fleming (17), which involves a Roese-Gottlieb extraction, ashing the extract with magnesium nitrate, and determination of phosphorus therein by the Fiske-Subbarow (4) method.

[3] Palmer and Wiese (12) found that acidification to this point produced maximum precipitation from dialyzed "membrane" concentrates. Its use for unconcentrated "membrane" sols was suggested by Olson (9).

Protein in washed cream was determined by the dioxan precipitation technique introduced by Rimpila and Palmer (14). This consisted of adding 8 ml.[4] of dioxan per gram of cream, heating to 50–60° C. for a few minutes, cooling to room temperature, filtering off the protein on a tared sintered glass crucible, extracting the latter with ether for 12 hours, drying, and weighing. Lipide phosphorus was determined in the combined dioxan filtrate and ether extract (called "dioxan extract" herein) in the same manner as in the Roese-Gottlieb alcohol-ether extract.

Dioxan in the 8:1 ratio was found suitable for precipitating protein from washed cream butter and from liquid "membrane" sols, both concentrated and unconcentrated. The "dioxan extracts" from each of these products were used for the determination of lipide phosphorus.

Dried "membrane" preparations were extracted with absolute ethanol for 48 hours followed by absolute ether for 36 hours.[5] Phosphorus was determined in the combined extract by the Fiske-Subbarow (4) method after ashing with magnesium nitrate. The composition of the dried "membrane" preparations was calculated as follows:

Protein = Residue remaining after extraction
Phospholipide = (Phosphorus in extract) × 25.97
Phosphorus-free lipide = Extract minus phospholipide

RESULTS

Preliminary study of composition of the "membrane" and distribution of its constituents upon churning. Four summer and six winter creams, obtained from several groups of cows, were handled in the manner described, and after churning, the buttermilk and butter serum were separately supercentrifuged at 31,000 r.p.m., concentrated by pervaporation, dried, and extracted.

Table 1 shows that there are considerable variations in the quantity and composition of "membrane" material isolated by these methods. There seems to be no general relation between these variations and breed or season. The percentages of protein and phospholipide in the "membrane" are not unlike those reported by Rimpila and Palmer (14), and furthermore the actual yields of these materials in buttermilk plus butter correspond well to those found by Rimpila (13). However, the fact that considerable quantities of both protein and phospholipide were thrown out in the supercentrifuge bowl, from which it was difficult to recover them, precluded the use of this method for quantitative studies.

The one outstanding result of this preliminary study was the establish-

[4] This ratio was found slightly more satisfactory than the 7:1 ratio used by Rimpila and Palmer (14).

[5] Bailey-Walker equipment was used for small quantities and large Soxhlets for large quantities of material.

ment of the fact that the ratio of protein to phospholipide is not identical in buttermilk and butter serum. The latter fraction invariably contained a decidedly greater amount of phospholipide per unit of protein.

The effect of changes in fat composition on composition and distribution of the "membrane." This study was made to determine whether a feeding regime which produces extremely high melting milk fat has any influence on yield, composition, or distribution of materials adsorbed on the fat globules.

Creams were studied from two pairs of Holsteins and one pair of Guernseys all in the seventh month of lactation. For three months they had been

TABLE 1

Yield and distribution of "membrane" materials

Cream No.	Breed of cow	"Membrane" from supercentrifuged buttermilk				"Membrane" from supercentrifuged butter serum				Prot./P-lipide in sum
		Yield per 100 gms. fat*	Protein	Phospho-lipide	Prot./P-lipide	Yield per 100 gms. fat*	Protein	Phospho-lipide	Prot./P-lipide	
Summer 1941		*gms.*	%	%		*gms.*	%	%		
1	Jer.	0.30	45.0	12.7	3.5	0.26	32.5	25.5	1.3	2.1
2	"	0.37	49.0	15.7	3.1	0.16	36.3	28.7	1.3	2.3
3	Hols.	0.47	45.7	16.4	2.8	0.22	28.9	13.8	2.1	2.6
4	"	0.57	37.3	.....	.....	0.19	40.2	.....	.....	.....
Winter 1941–1942										
5	Jer.	0.50	42.2	18.5	2.3	0.16	20.5	24.0	0.8	1.9
6	"	0.47	36.7	17.8	2.1	0.14	19.2	17.5	1.1	1.7
7	"	0.19	33.1	12.4	2.7	0.16	27.6	19.8	1.4	2.0
8	Hols.	0.30	38.6	13.2	2.9	0.10	37.6	24.0	1.6	2.5
9	"	0.33	39.1	12.4	3.2	0.17	29.6	24.3	1.2	2.2
10	Ayr.†	0.62	31.8	17.0	1.9	0.17	26.6	33.2	0.8	1.5

* Refers to fat in washed cream.
† Cows on ration of alfalfa hay only.

fed alfalfa hay, a grain mixture consisting of whole cottonseed and ground barley (3:1), plus 1–3 pounds of cottonseed oil per cow per day.[6] Creams 11 to 15 inclusive were secured while the cows were on this ration. They were then shifted to the herd ration consisting of alfalfa hay, corn silage, and a grain mixture of equal parts linseed oil meal, corn meal, ground oats, and wheat bran; after three weeks, creams 16 to 21 inclusive were secured.

The creams were washed and churned by the standard procedure. As expected, the creams produced on the herd ration churned much more quickly than those produced during cottonseed feeding. The buttermilk and

[6] In connection with an experiment designed to produce high-melting butter.

butter serum were not supercentrifuged, but were separately concentrated by pervaporation, dried in vacuum, and extracted. Since no supercentrifugation was made, the dried material contained considerable butterfat in addition to "membrane," but analyses for protein and phospholipides and calculation of their ratio were possible.

Results of these studies, recorded in table 2, show that, generally, greater amounts of protein and phospholipide are found in the buttermilk and butter serum when they are not supercentrifuged (compare with table 1). The ratios of protein to phospholipide are, however, consistent with those previously found, thus indicating that supercentrifuging probably had not fractionated the "membrane" materials qualitatively.

TABLE 2

Composition of "membrane" material in creams produced on two different rations

Cream No.	Cow pair	Free buttermilk			Butter serum			Prot. / P-lipide in sum
		Protein	Phospho-lipide	Prot. / P-lipide	Protein	Phospho-lipide	Prot. / P-lipide	
Cottonseed Ration		*gms./100 gms. fat**			*gms./100 gms. fat**			
11	Hols. A	0.38	0.15	2.5	0.08	0.11	0.7	1.8
12	" "	0.42	0.16	2.6	0.09	0.11	0.8	1.9
13	Hols. B	0.20	0.07	2.8	0.11	0.08	1.4	2.1
14	Guer. C	0.27	.....	.....	0.14	0.13	1.1	.....
15	" "	0.35	0.13	2.7	0.14	0.13	1.1	1.9
Herd Ration								
16	Hols. A	0.41	0.15	2.7	0.17	0.20	0.8	1.6
17	" "	0.39	0.12	3.2	0.11	0.09	1.2	2.4
18	Hols. B	0.26	0.10	2.6	.....	.....	.....	.....
19	" "	0.27	0.09	3.4	0.08	0.06	1.3	2.3
20	Guer. C	0.35	0.12	2.9	0.17	0.17	1.0	1.8
21	" "	0.35	0.11	3.2	0.14	0.11	1.3	2.2

* Refers to fat in washed cream.

There appears to be no great difference in amount or distribution of protein or phospholipides that may be attributed to the ration, but the possibilities of differences between individual cows is suggested by the fact that creams from pair B yielded lower amounts of protein and phospholipides particularly in the free buttermilk. Qualitative observations indicated that this difference might be due to differences in fat globule size, since the fat globules from pair B appeared to average larger than those from pairs A or C.

Natural variations in the amounts of adsorbed materials and their relation to fat globule size. It was felt that the methods used in the first two series of experiments had allowed the possibility of rather large and perhaps variable losses of materials. Therefore, another study was conducted in which determinations were made directly on the washed cream. Protein was determined by the dioxan method and phosphorus analyses were made on both the dioxan- and Roese-Gottlieb extracts.

Since qualitative observations had indicated that the yield of "membrane" may possibly be related to fat globule size, measurements were made of the fat globules in some of the washed creams. The technique used for this purpose was similar to that described by Farrall, Walts, and Hanson (3) and later successfully applied by Doan and Mykleby (2). Frequency distributions were made into classes having diameter ranges of 0.8 μ and the fat surface per 100 grams of fat was calculated.

The data in table 3 indicate that relatively constant amounts of protein and lipide phosphorus are present per 100 grams of fat in the washed cream

TABLE 3

"Membrane" constituents in washed creams from several groups of cows

Cream No.	Cow group	Breed	Constituents of washed cream per 100 gms. fat				Fat surface per 100 gms. fat	Constituents of washed cream per 100 cm.²	
			Protein	Lipide phosphorus		Total phosphorus		Protein	Lipide–P†
				R–G*	Dioxan†				
			gms.	*mgms.*	*mgms.*	*mgms.*	*cm.²* × 10^6	*μg.*	*μg.*
22	D	Hols.	0.75	.....	16.3	.....	.....	.....	.....
23			0.74	.....	15.2	16.8	.....	.....	.....
25			0.86	.....	.....	.....	.....	.....	.....
26			0.80	.....	.....	.....	.....	.....	.....
32			0.80	.....	13.6	18.6	.....	.....	.....
36	E	Hols.	0.59	.....	11.2	.....	1.64	36	0.68
38			0.76	12.6	13.8	.....	1.77	43	0.78
42			0.74	13.4	12.4	.....	1.68	44	0.74
40	F	Hols.	0.66	10.8	10.8	12.4	1.91	35	0.57
41			0.65	12.0	13.9	.....	.....	.....	.....
34	K	Hols.	0.78	9.2	11.0	16.9	1.60	49	0.69
37	J	Hols.	0.81	.....	15.1	.....	2.05	39	0.74
39	L	Hols.	0.60	10.8	10.3	.....	1.64	36	0.63
48	N	Hols.	0.76	.....	16.4	.....	1.91	40	0.86
24	G	Jer.	0.48	8.9	.....	12.3	.....	.....	.....
27			0.46	.....	.....	.....	.....	.....	.....
47	M	Jer.	0.50	.....	10.9	.....	1.46	34	0.74
43	H	Mixed	0.49	.....	10.4	.....	.....	.....	.....
45			0.68	.....	11.5	.....	1.70	40	0.68

* Roese-Gottlieb extract.
† "Dioxan extract."

from a given group of cows. Some difference between breeds in protein content is indicated also, but the data are insufficient to indicate whether there is a breed difference in the level of lipide phosphorus.

The lipide phosphorus contents of the washed creams are not unlike those reported by other workers (5, 6, 14). The efficiency of the dioxan extraction of lipide phosphorus compared favorably to that of the Roese-Gottlieb extraction, but considerable retention of phosphorus (not necessarily lipide phosphorus) by the dioxan precipitated protein is revealed by the difference

between total and dioxan extract phosphorus. The amounts of protein and phosphorus per unit of fat surface were strikingly uniform in the ten samples for which this information was obtained, but these all showed approximately the same specific fat surface.

Next, samples exhibiting a wider range of specific fat surface were prepared by the fractional separation technique of Shaw and Eckles (16). This involved a preliminary separation with the Sharples supercentrifuge geared down to about 9,000 r.p.m., followed by reseparation of the "cream" (8–12 per cent fat) at about 12,000 r.p.m., and of the skim milk (0.4–0.5 per cent fat) at about 22,000 r.p.m. In some cases the fractionation was made before,[7] and in others after, washing, but the measurements were made after washing in all cases.

The results of this experiment, given in table 4, show a decided difference in fat globule size in the two fractions. As expected, greater amounts of both protein and lipide phosphorus per unit weight of fat were found in the small globule fractions. In fact, for the 19 samples shown in tables 3 and 4 on which measurements were made, the correlation coefficients between surface per 100 grams and (1) protein per 100 grams and (2) lipide phosphorus per 100 grams are respectively + 0.93 and + 0.84, both of which far exceed the 1 per cent level of significance.

TABLE 4

Relation of yield of "membrane" constituents to size of fat globules

Cream No.	Cow group	Breed	Fraction	Fat surface per 100 gms. fat	Protein per		P in dioxan extract per		Prot. / P–lipide
					100 gms. fat	100 cm.²	100 gms. fat	100 cm.²	
Fractions separated before washing									
				$cm.^2 \times 10^3$	*gms.*	*μg.*	*mgms.*	*μg.*	
29	D	Hols.	L.G.*	1.73	0.88	51	18.2	1.10	1.9
			S.G.†	2.34	1.68	72	30.0	1.30	2.2
33	P	Hols.	L.G.	1.78	0.90	50	17.6	0.99	2.0
30	G	Jer.	L.G.	1.56	0.55	35	13.5	0.86	1.6
31			S.G.	2.75	1.83	66	24.3	0.88	2.9
Fractions separated after washing									
48	N	Hols.	N.F.‡	1.91	0.76	40	16.4	0.86	1.8
			L.G.	1.79	0.55	31	14.0	0.78	1.5
			S.G.	2.59	1.93	74	40.5	1.56	1.9
47	M	Jer.	N.F.	1.46	0.50	34	10.9	0.74	1.8
			L.G.	1.43	0.45	31	9.4	0.66	1.9
			S.G.	1.94	0.88	46	20.8	1.07	1.6

* Large globule.
† Small globule.
‡ Not fractionated.

[7] When fractionation preceded washing, a speed of 22,000 r.p.m. was necessary in washing the small globule fraction.

Furthermore, it appears that more of these substances are present *per unit of fat surface* in the small globule fractions. For the 19 samples, the correlation coefficients are + 0.82 between surface and protein per unit of surface and + 0.63 between surface and lipide phosphorus per unit of surface,

TABLE 5

Partition of "membrane" materials between washed-cream buttermilk and butter serum

Cream No.	Washed cream			Buttermilk			Butter serum			Recovery*	
	Protein	Phospholipide	Prot./P-lipide	Protein	Phospholipide	Prot./P-lipide	Protein	Phospholipide	Prot./P-lipide	Protein	Phospholipide
Precipitated with dioxan											
	gms./100 gms. fat			*gms./100 gms. fat*			*gms./100 gms. fat*			%	%
22	0.75	0.42	1.8	.....	.....	....	.....	.....	....	.....	.....
23	0.74	0.40	1.9	0.46	0.12	3.8	0.21	0.16	1.3	90.1	71.0
24	0.48	0.23	2.1	.....	.....	....	.....	.....	....	.....	.....
32	0.80	0.35	2.3	0.44	0.14	3.0	0.16	0.16	1.0	74.5	85.4
34	0.78	0.29	2.7	0.25	0.09	2.7	0.24	0.15	1.5	62.8	86.8
36	0.59	0.29	2.0	0.17	0.07	2.4	0.21	0.11	2.0	65.9	62.5
37	0.81	0.39	2.1	0.34	0.12	2.9	0.24	0.14	1.7	70.9	65.9
38	0.76	0.36	2.1	0.40	0.17	2.4	0.24	0.14	1.7	83.1	85.4
39	0.60	0.27	2.2	0.28	0.10	2.7	0.27	0.18	1.5	91.5	104.8
40	0.66	0.28	2.4	.....	.....	....	.....	.....	....	.....	.....
41	0.65	0.36	1.8	0.37	0.14	2.6	0.26	0.20	1.3	98.4	93.4
42	0.74	0.32	2.3	0.42	0.16	2.7	0.24	0.22	1.1	89.2	115.2
43	0.49	0.27	1.8	0.25	0.10	2.4	0.30†	0.16	1.8	110.0	97.6
45	0.68	0.30	2.3	0.39	0.13	3.1	0.29†	0.18	1.6	100.0	103.3
47	0.50	0.28	1.8	.....	.....	....	.....	.....	....	.....	.....
48	0.76	0.43	1.8	.....	.....	....	.....	.....	....	.....	.....
Pervaporated, dried and extracted											
22	.....	.....	....	0.30	0.08	3.9	0.14	0.11	1.3	59.2	44.7
23	.....	.....	....	0.35	0.10	3.5	0.14	0.17	0.8	66.1	70.4
44	.....	.....	....	0.32	0.10	3.2	0.19	0.16	1.2	.....	.....
Precipitated at pH 4.0, dried and extracted											
22	.....	.....	....	0.28	0.07	3.8	0.13	0.12	1.1	54.8	44.5
23	.....	.....	....	0.39	0.12	3.3	0.17	0.18	0.9	75.7	76.6
24	.....	.....	....	0.19	0.06	3.1	0.13	0.11	1.2	67.6	.....

* Calculated as percentage of amount in washed cream by dioxan method that was recovered in buttermilk and butter serum.

† Analyses made directly on butter.

both again exceeding the 1 per cent level. Whether this finding signifies (1) greater original adsorption on the small globules, (2) greater retention by the small globules during washing, or (3) a systematic error in measurement, cannot be decided from these data.

The protein/phospholipide ratios in table 4 give no consistent evidence of different proportions of these constituents on globules of different size.

Partition of adsorbed materials between buttermilk and butter serum when washed cream is churned. Some of the creams reported in the preceding section were churned in order to determine the distribution of "membrane" constituents between buttermilk and butter serum. Most of the analyses of these fractions were made by the dioxan method, but in a few cases they were concentrated, dried, and extracted. None of them was supercentrifuged. The analyses are given in table 5.

For samples 22, 23, 29, 31, 32, 34, 36 and 37, the recovery in buttermilk and butter serum of materials present in the cream was unreasonably low. Greater care in collecting and handling buttermilk and butter serum is probably responsible for the better recoveries in samples 38, 39, 41 and 42. Analyses were made directly on the butter of samples 43 and 45 with reasonable recoveries.

The protein/phospholipide ratios of the washed creams are of the same order of magnitude as those previously calculated from summations of "membrane" materials in buttermilk and butter plasma (see tables 1 and 2). That this is so in spite of recovery of considerably greater amounts of both protein and phospholipide by the dioxan method supports the validity of the earlier ratios.

In agreement with the earlier results reported herein the butter serum contained decidedly more phospholipide per unit of protein than did the buttermilk. Furthermore, although the recoveries were reduced by concentrating, drying, and extracting, the ratios were not altered appreciably thereby.

Another noteworthy fact shown in table 5 is the contrast between the relative constancy of the amount of protein in the butter serum and the variability of that in the buttermilk. On the other hand, the phospholipide contents of both buttermilk and butter serum appear to be variable. It would appear from these results, that churning involves "erosion" of protein to a critical minimum before butter forms. The phospholipides are not affected in the same manner, their contents in both butter and buttermilk being somewhat proportional to that in washed cream.

The ratio of buttermilk-protein/butter-serum-protein calculated from the data of table 5, ranged from 0.81 to 2.75. The corresponding ratio for phospholipides was more nearly constant, ranging from 0.57 to 0.92 in 10 of the samples and being 1.23 in the eleventh.

It is to be noted, of course, that the contents of protein and phospholipide are expressed herein per unit of fat in the washed cream and that the *concentration* of these materials per unit of buttermilk or of butter serum was invariably much greater in the latter. Thus it was calculated that in the experiments reported in table 5 the buttermilks contained 0.08–0.22 per

TABLE 6

Partition of "membrane" materials between buttermilk and butter churned from washed creams of varying fat content

Cream No.	Fat content of cream	Protein precipitated by dioxan from			Phosphorus in dioxan extract from		
		Washed cream	Buttermilk	Butter serum	Washed cream	Buttermilk	Butter serum
	%	*gms./100 gms. fat*			*mgms./100 gms. fat*		
41a	20.0	0.61	0.38	0.26	13.3	5.4	7.4
41b	27.0	0.67	0.37	0.25	14.2	6.0	7.8
41c	34.0	0.67	0.37	0.28	14.1	5.4	8.0
43a	20.5	0.49	0.23	0.31	9.4	5.5	6.6
43b	26.0	0.50	0.24	0.30	9.2	3.9	6.2
43c	31.0	0.49	0.26	0.29	.....	3.6	6.3
43d	36.0	0.50	0.26	0.29	10.7	3.6	5.9
43e	41.0	0.49	0.23	0.30	8.8	3.0	6.1

cent protein and 0.03–0.08 per cent phospholipide. The butter sera, on the other hand, contained 0.80–1.50 per cent protein and 0.55–1.10 per cent phospholipide.

All of the churnings reported heretofore were made with creams of uniform fat content. It appeared of interest to study the partition of "membrane" constituents upon churning creams of varying fat content. For this purpose, two samples of washed cream were each standardized to a series of fat contents with distilled water, cooled to 0–5° C., held overnight, and churned as usual. Data from these experiments, shown in table 6, point to a rather constant retention of protein in the butter regardless of the fat percentage or the protein content of the washed cream. Here, again, the

TABLE 7

Effects of aging before washing and agitation before churning on distribution of "membrane" materials

Cream No.	Treatment before		Protein precipitated by dioxan from			Phosphorus in dioxan extract from		
	Washing	Churning	Washed cream	Buttermilk	Butter serum	Washed cream	Buttermilk	Butter serum
			gms./100 gms. fat			*mgms./100 gms. fat*		
40a	None*	None	0.66	.....	.....	10.8	.....	.....
40b	Aged†	None	0.45	.....	.....	8.7	.....	.....
45a	None*	None	0.68	0.36	0.26	11.5	4.8	7.0
45b	None*	Agitated‡	0.68	0.39	0.29	11.5	4.8	5.5
45c	Aged†	None	0.42	0.21	0.22	9.7	2.8	5.7
45d	Aged and agitated§	.....	Oiled off on second washing					

* Milk separated and cream washed without cooling.

† Milk cooled to 3.3° C., held 24 hrs., warmed to 43.3° C., held 1 hr., separated, and cream washed.

‡ Cream agitated with high-speed stirrer 1 hr. at 3.3° C. before churning.

§ Milk cooled to 3.3° C., held 24 hrs., agitated 1 hr. with high-speed stirrer, warmed to 43.3° C. and separated.

concentration of phospholipides in both buttermilk and butter appears to be proportional to their concentration in the washed cream, but to be unrelated to the fat content. No explanation is apparent for the high phospholipide content of the buttermilk of sample 43a in relation to those of the other samples of cream 43.

The foregoing results aroused interest in the question of whether other means than churning would cause movement of adsorbed materials from fat surface to plasma in milk and cream. Results of a few experiments in this connection are reported in table 7. Definite indications were obtained that mere aging of milk at low temperature followed by rewarming before separation greatly decreases the retention of protein and phospholipide during washing. This finding emphasizes the importance of using uncooled milk for washing experiments. Agitation of aged milk at 3.3° C. for one hour immediately before rewarming for separation resulted in the production of an unstable cream that oiled off at the second washing. Churning had apparently occurred to some extent. Whipping of washed cream by agitation at 3.3° C. immediately before churning did not affect (a) the churning time or (b) the amount of adsorbed materials released into the buttermilk.

DISCUSSION

This study verifies the findings of Rimpila and Palmer (14) in regard to the quantity and proportions of materials so closely adsorbed on the fat globules of cream as to resist removal by six successive washings with distilled water. Furthermore, the demonstration of a correlation between specific fat surface and quantities of material adsorbed, gives a clue as to what natural factors may influence the "membrane"; any of the well-known conditions affecting the size of the fat globules possibly may influence the quantity of "membrane" materials.

In view of the high capillary activity of phospholipides, the finding that washed-cream butter serum is richer in phospholipide per unit of protein than is washed-cream buttermilk, gives point to the observation of Powell (see Palmer (10)) that washed-cream butter serum is a more effective depressant of interfacial tension per unit of protein than is washed-cream buttermilk. The significance of this result can, as yet, only be speculated upon. One would ordinarily consider that the phospholipides are preferentially oriented to the fat phase and protein to the water phase. Indeed, such a concept has been advanced on theoretical grounds by Bird, Breazeale, and Bartle (1). If this be true, and if churning be considered to involve a progressive "erosion" of material from the fat globule surface, it is not at all unreasonable to suppose that the original lipoprotein complex constituting the "membrane" may become disrupted in such a manner as to release a comparatively protein-rich portion to the free buttermilk.

That an "erosion" of protein to a critical level does occur during the churning process is substantiated by the finding that a rather constant level

of protein remained in the butter regardless of the amount originally present in the washed cream. The fact that a constant level of phospholipide was not found in butter serum seems to indicate that the protein, as it is "eroded," pulls away varying amounts of phospholipide with it. This belief is strengthened by the fact that the ratio of protein to phospholipide in the buttermilk is not absolutely constant. Our data, of course, give no clue as to whether the "erosion" to a critical level in churning involves the complete destabilization of a portion of the globules to liberate fat which then cements the other globules together as visualized by Levowitz and van der Meulen (7), or whether it involves "denuding" all of the globules to about the same degree.

SUMMARY

Protein contents ranging from 0.46–0.86 grams per 100 grams of fat, and lipide phosphorus contents ranging from 8.9–16.3 milligrams per 100 grams of fat were found in 19 samples of cream washed six times with distilled water. The protein content was relatively constant in washed creams from any given group of cows; it was lower in those from Jerseys than in those from Holsteins. The protein/phospholipide ratio varied from 1.8 to 2.4 in 15 samples of washed cream and was 2.7 in a sixteenth.

Protein and phospholipide contents and ratios of washed creams appeared to be independent of variations in fat composition produced by changes in feed.

The protein and lipide phosphorus contents of 10 samples of washed cream, exhibiting only minor variations in average fat globule size, were respectively 34.0–49.0 and 0.57–0.86 micrograms per 100 square centimeters of fat surface.

Contents of "membrane" constituents per unit weight of fat and even per unit of fat surface were correlated significantly with the specific fat surface in 19 samples of washed cream prepared to exhibit a considerable range in average fat globule size.

Butters from 11 samples of washed cream had protein/phospholipide ratios of 1.0–2.0. The corresponding buttermilks had ratios of 2.4–3.8. This verified the rather qualitative results of a preliminary investigation.

Butters from washed cream retained protein at a rather constant level of 0.21–0.30 grams per 100 grams of fat irrespective of the concentration of fat or of protein in the washed creams from which they were churned. They did not retain a constant level of phospholipide.

The significance of these findings in relation to a theoretical concept of orientation of protein and phospholipide in the "membrane" is discussed.

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THE FORTIETH ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ, *Secretary-Treasurer*

The Executive Committee of the American Dairy Science Association met in the Stevens Hotel, Chicago, Illinois, on Tuesday, June 12, 1945, at 10 A.M. Members present were: A. C. Ragsdale, President; J. A. Nelson, Vice-President; R. B. Stoltz, Secretary-Treasurer; T. S. Sutton, Editor; P. A. Downs, J. W. Linn, P. H. Tracy, C. L. Blackman, R. B. Becker, W. E. Petersen, and A. C. Dahlberg, Directors. Guests present were: G. M. Trout and G. W. Salisbury.

The President of the American Dairy Science Association, A. C. Ragsdale, called the meeting to order and gave the following annual address:

President's Address

NEW FRONTIERS IN DAIRY SCIENCE

A. C. RAGSDALE

The 40th annual meeting of the American Dairy Science Association has been cancelled by unanimous vote of the Board of Directors, due to restrictions placed by our Government on travel not considered essential to the prosecution of the war. Valuable as are the contributions of dairy science and important as are personal conferences and group discussions, we have responded in the confidence that our contributions will still be translated into action and service. Our Association has today the second largest active membership and our Journal the third largest circulation in our history. We have among our members today more scholars, research workers and teachers who are well chosen, well trained and well supplied with facilities, men with brains and character, and more prospective students who are ambitious to join our ranks, than perhaps ever before. Surely there are new frontiers ahead.

Whether we are engaged in research, teaching, extension, milk production, processing, manufacturing or merchandising dairy products, we have before us the greatest opportunity in history. One lesson of this war is that the possession of a sound and creative technology tends to assure military and economic security. It seems clear that in the years ahead the progressive nations of the world will pursue a policy of intensive scientific and technological research. Can our American Colleges and Universities maintain their place of leadership in research and teaching? The importance of scholarship, research and good teaching needs to be better understood. In a democracy such as ours, public support to insure an adequate budget comes

only when the values of research, all kinds of research, are widely understood.

There is a tendency on the part of the teacher searching for a means to improve education to center his efforts on the curriculum. Improvements can be made in that quarter and our Association has taken the lead in developing improved curricula in dairying. My purpose, however, is to direct our thoughts toward the men who teach, who develop new theories and techniques, whose researches provide the basic material which will enable us to meet the challenge of the host of young men and women who will be coming to our colleges seeking to prepare themselves for the keen competition that lies ahead as new frontiers in science and technological developments unfold.

How can top-rank students be attracted to dairying? Would scholarships offered by dairy and allied industries aid in this respect? We are being called upon to furnish men for industry who are prepared to attack research and operational problems that challenge the best minds. It is our responsibility to do everything in our power to attract, select, properly educate and develop the scientifically promising young men of high caliber who choose dairying as their vocation.

Large businesses are planning to expand their research activities. Much of this planning and expansion is now under way. The beginning of sharp competition for the best brains in science and the dairy industry is clearly discernible. This quickening in demand for well-trained men is, however, only part of the picture. The crucial importance of resuming and expanding scientific training must be recognized and acted upon by our colleges so that they may successfully rebuild their staffs to meet the mounting postwar training load.

How can public appreciation of the dairy profession be widened and deepened? One out of every 15 families in the United States is dependent on milk for a livelihood. There are numerous national, state and regional organizations serving the dairy industry in a wide variety of ways, yet we have far to go in an advertising program or otherwise presenting the merits of milk and its products to the public before we approach the effectiveness of many who provide inferior and less essential products.

DAIRYING AS A PROFESSION

Dairy science, medical science and engineering have much in common. Each employs the various sciences and techniques that serve their respective professions. No one of them is an autonomous science, in the conventional sense. Each is a profession, an industry, a business, based on many sciences and techniques. The practicing dairyman, like the practicing physician, surgeon or engineer, applies various sciences and arts to the use of his specialty.

The dairy industry may be divided into production, processing, manu-

facture and distribution. Each of these fields is very complex. For instance, the phenomenon of milk production comprises virtually all biological sciences, including, among many others, chemistry, physiology, endocrinology, reproduction, bacteriology, nutrition, economics and agronomy. It includes problems concerning the nutritive value of milk and its products, how nutritive values are influenced by dietary components, by the nature of the cow's feed, soil, and so on. What is said about the complexity of milk production holds for milk processing, manufacture and distribution of dairy products.

No, "Dairy Science" is not a simple entity but a great complexity of sciences, arts, and industry, just as there is no one medical or engineering science, but great, complex medical and engineering professions. There are scientists in the dairy profession as in the medical and engineering professions. Educational, research and industrial institutions employ persons trained to the critically scientific way of thinking, analyzing, synthesizing, and acting. These persons may be trained in one or more of the basic sciences in which they choose to be specialists, but they also investigate phenomena of particular interest to the profession or business which employs them. Their researches are often fundamental, of general applicability, rather than of exclusive interest to the dairy, medical or engineering professions. By engaging in fundamental research, workers in these fields pay their debt to the interrelated sciences and professions. As more and more of our colleges of agriculture and dairy departments utilize such men, they will be enabled to do better research and teaching and contribute more to the industry and profession of which they are a part.

The principal concern of science is to add to our knowledge. Students and research workers must search for the truth diligently and present their findings without prejudice. Cooperation with workers trained in other fields may aid in making new discoveries, interpreting findings and eventually in suggesting the best utilization of the results. The mere accumulation of data is not enough to qualify it as research. Workers in dairy science need to know how to formulate worthwhile and clear-cut problems, develop methods for their solution and finally present the results in understandable form. All of us—professors as well as students—will find reading and writing an important aid in clarifying our ideas for ourselves as well as for our readers.

Let me illustrate this viewpoint as it relates to the research and teaching program of my own University of Missouri. In our Medical School, which is typical of at least the first two years of most medical schools, only about 60 per cent of the faculty have the professional M.D. degree, the other 40 per cent having degrees in the sciences such as chemistry, bio-chemistry, anatomy, physiology, bacteriology, and so on. The research work of these Ph.D's is seldom in medicine, in the narrow meaning of the word. So in our Col-

lege of Engineering and in our own Dairy Department, as indeed in others in this country, men with degrees in mathematics, physics, chemistry, physiology, bacteriology, etc., have played most important parts in the research programs of their colleges and departments. These men are contributing toward making Medicine, Engineering and Dairying the progressive professions they are. They are keeping the professions on the scientifically objective level. Their investigations may not always contribute directly to the facts of medicine, engineering or dairying, but by their mere presence and activities they contribute to the spirit and standing of each profession, even as over the longer term their researches aid it.

One of the greatest of American experiment station directors, F. B. Mumford of Missouri, recognized the importance of the so-called "pure" or "impractical" research in agriculture and paid it high tribute in his address on the occasion of the 50th anniversary of the Missouri Agricultural Experiment Station, when he said that such apparently impractical investigations sometimes offering little in the way of immediate application are important because "they have dignified the calling of agriculture and have given the farmer intellectual background and a basis for his thinking that cannot be easily measured."

The man who would advance science cannot afford to ignore its history—especially the part played by gifted and vigorous leaders. Science, with its eyes ever to the future, must not forget the lessons of the past in its concern for tomorrow. New discoveries are the life blood of science but to our institutions of higher education traditionally belongs the obligation of preserving the "old knowledge," the wisdom of the ages. There must be appreciation of scholarship on the part of both teachers and students if we are to train men prepared to meet fully the needs of our profession and the needs of society.

Let me cite several well-known examples of such so-called "pure" or fundamental researches which have contributed mightily to the dairy industry. Lavoisier is considered to be the founder of the science of nutrition, at least as it relates to its energetic or calorimetric aspects and to the nature of oxidation. The practical people of his day did not appreciate Lavoisier's genius and on May 8, 1794, they chopped off his head with the guillotine. He was not a dairyman, nevertheless he furnished the theoretical basis for such modern "stock-in-trade" as energy units and feeding standards.

A French chemist, Louis Pasteur, similarly contributed mightily to the dairy industry by his method of pasteurization described in 1873. Pasteur also contributed to medicine by his method of treating rabies by inoculation with virus of gradually increasing strength and also discovered immunization against anthrax and chicken cholera.

Vitamin values of milk were discovered and rediscovered by a long array of chemists and physiologists. For instance, C. A. Pekelharing in 1905 ob-

served that mice could not live on purified proteins, fats, carbohydrates and ash, but that if a few drops of milk were added they throve. So, he announced the widely quoted conclusion that "there is a substance which even in small amounts is of paramount importance in nutrition." This is now known to consist of the vitamins. Likewise, in 1906 and again in 1912, F. G. Hopkins observed and in 1911 Mendel and Osborne observed, that rats would not survive on purified substances unless a drop of deproteinized milk or milk serum was added to the diet. Hopkins, therefore, concluded that animals must have some "accessory food substances," now referred to as water-soluble or B-complex vitamins. All dairymen, of course, know that in 1913 McCollum and Davis and Osborne and Mendel discovered, simultaneously, the fat-soluble vitamin A in milk fat and that in 1915 McCollum and Davis discovered the water-soluble vitamin B (B-complex vitamins) in skim milk, and that it was recognized during the first World War that the epidemic of blindness among Danish children was due to a butterfat shortage. Vegetable fats do not have vitamin A. Burr, a botanist and chemist, reported in 1929 that certain fatty acids are dietary essentials and Hilditch, a chemist, reported that butterfat contains 2 to 4 per cent of these fatty acids.

The story of carotene and its relation to vitamin A is among the most fascinating chapters of dairy science. You are all familiar with the 1914 classic series of papers on carotene and related pigments by Palmer and associates of the Department of Dairy Husbandry, Missouri Agricultural Experiment Station. This material was summarized in 1922 in Palmer's well-known book entitled "Carotinoid and Related Pigments." In 1920 Steenbock and associates and in 1922 Kennedy and Dutcher observed that these pigments found in yellow corn had vitamin A properties, and that the pigment in butterfat is derived from the feed. T. Moore, in 1930, discovered that carotene may be stored in the liver in the form of colorless vitamin A and Karrer in 1930 discovered that vitamin A is in fact carotene. Some 16 years elapsed between the pioneering work on milk pigments at the Missouri Station and the discovery of their nutritional significance by an organic chemist in Switzerland.

Clarence Henry Eckles, one of the founders of the American Dairy Science Association, whose influence was strongly felt in the establishment of the JOURNAL OF DAIRY SCIENCE, was one of the first in this country to apply his training in scientific methods to the solution of dairy problems. An energetic scientific worker, an inspiring teacher and wise counsellor, few men have had the privilege of guiding so many students toward scientific achievement. Investigations relating to the effect of food on the chemical composition of milk and its products and to the nutrition and physiological development of dairy cattle were among his major interests. "Why," asked Eckles, "do cows of the same general appearance, some half-sisters, vary so widely in their ability to produce milk and fat?" Teachers today could use

more of the qualities which attracted and inspired in his students appreciation for the values of character, scholarship, love of research, zeal for the truth, and willingness to work.

A recital of these cold facts may not stir the imagination and may not seem to some to play such a vital part in our lives as do some of the advances in medical science paced by blood plasma, penicillin and sulfa drugs, but they have been tremendously important in human welfare and are typical of values which may be derived when men well trained in fundamental sciences are included in our dairy departments and closely related fields of agriculture, or where cooperation of dairying and related sciences is developed.

It is my purpose to suggest that there are new opportunities ahead of us in dairy science and that we may forge ahead as we meet the challenge, as we provide some real "meat" for the host of promising young scientists that will shortly be crowding our colleges and that while not overlooking the merit of so-called "practical" research, with its more immediate application, we think in terms of long-time contributions to the welfare of agriculture and the dairy industry.

Every state in this country has colleges equipped with dairy departments. Contributions to the real advancement of dairy science are coming from too few, perhaps in part because of inadequate support. We must educate the public as to the values of fundamental research—to understand what it needs from us. It needs a vast amount of service from our sciences but it wants all too little. Scientists appreciate too little the value of "selling" the results of their work. Institutions dependent on public funds seldom have the necessary organization to get all the money needed to do the job most effectively. In this connection I might refer to the growing appreciation of our general need of medical attention. It is the job of the dairy and agricultural sciences to educate the public to what it needs in the way of service in these fields just as the medical profession has done in its field.

SOME INDUSTRY PROBLEMS

Dairying, as an industry, contributes more to agricultural stability and public health than any other. The future of dairying lies in a full appreciation of the nutritive values of milk and milk products.

Greater efficiency in production is important. The techniques to be used are improvement in feeding, breeding, health-control and herd-management practices. Pastures, silage and dry roughages of *high quality* offer opportunity for both lower cost production and greater *nutritive values* in the milk. Artificial breeding may be a most important tool in herd improvement. Will the potentialities of this method be used in such a way as to more quickly improve the quality of our cattle?

More efficient methods in the handling and distribution of fluid milk and milk products are sure to be developed. Fluid milk distribution is in for

innovations and economies, especially in transportation and delivery costs. There are opportunities for improving packaging and merchandising. Will more whole milk be concentrated in plants near the farm? Should the dairy industry accelerate its promotion of concentrated and dry milks in the home?

What are to be the future trends in milk sanitation? Is farm or platform inspection to be emphasized?

Complete utilization of the total milk production—butter-fat, skim milk and whey, so that each part of milk may be used for the greatest nutritional value to society—is a problem we must solve. Are dairy plants of the future going to buy more whole milk? Will human beings, after they fully understand food values, outbid calves, hogs and chickens for skim milk? Will milk be purchased on a basis that fully recognizes the value of all milk solids?

How are "margarine" and "filled milk" to affect the Dairy Industry? What developments and public reactions can we expect in these fields? Should the emphasis be placed on the legislative or educational approach in moulding public opinion?

Most of us understand that the Dairy Industry can prosper only as potential buyers have purchasing power. What should be the publicity approach in merchandising dairy products? Should it be primarily from the standpoint of profit to the Industry or should we emphasize the broader approach of service to society? Do such agencies as the National Dairy Council and the American Dairy Association meet the needs of the public?

Is there a possibility of improved national nutrition through the development and widespread use of a whole-milk spread? Would it be possible to develop a milk bread that would approach nutritional completeness? Should we encourage the development of such a bread in the interest of public welfare? Should we develop milk wafers and milk candy that would appeal to children?

The above are simply a few examples of problems that we cannot ignore, the answer to which we must find.

As I close this brief message I would not have you feel that I am unappreciative of the enormous contributions that each and every one of our colleges and many of our commercial research laboratories are making toward the improvement of dairying and the training of men for farm, plant and public health aspects of our industry. Rather I have attempted to emphasize the values of adequately trained personnel, adequately supported, who can set the pace for American leadership of the world in our science, our profession and our industry. Colleges so staffed should assure teaching of a quality that will meet the highest standards and ideals of the most promising students with whom we will shortly have the opportunity to work and for whom we must provide guidance and inspiration.

EDITOR'S REPORT

Editor Sutton then gave the following report:

The contents of Volume 27 of the JOURNAL OF DAIRY SCIENCE are summarized in table 1 and a similar breakdown for Volume 26 is included for comparison. It will be noted that 92 papers were published in Volume 27. Forty-two of these papers dealt with manufacturing subjects and 50 with production subjects. This is quite different from Volume 26 in which 60 manufacturing papers and 38 production papers were published. We do not feel that this indicates a trend, rather it merely happened that during 1944 an unusually large number of production manuscripts were submitted for publication.

TABLE 1

Summary of Journal contents (Volumes 26 and 27)

	Volume 26 (1943)		Volume 27 (1944)	
	No.	Pages	No.	Pages
Manufacturing				
Original papers	59	542	40	356
Review papers	1	86	2	98
Production				
Original papers	38	362	50	410
Review papers	....	....	....	....
Miscellaneous	....	176	....	208
Total	98	1166	92	1072
Abstracts	....	264	....	208
Total pages printed	....	1430	....	1280

It will be noted that the total number of pages printed was lower in Volume 27 than in Volume 26. This does indicate a definite trend which may continue for several years to come. Table 2 shows the extent of the decrease in Journal size over the past five years.

TABLE 2

Journal size, Volumes 23–27 (1940–44)

Contents	Vol. 23 (1940)	Vol. 24 (1941)	Vol. 25 (1942)	Vol. 26 (1943)	Vol. 27 (1944)
	pages	*pages*	*pages*	*pages*	*pages*
Original papers	1284	1092	1078	1166	1072
Abstracts	254	422	362	264	208
Total	1538	1514	1440	1430	1280

The Journal reached its peak in size in 1940, when 1538 pages were printed. Total pages in 1944 were 1280 and present indications for Volume 28 are that there will be a further decrease. I do not believe that this is at all serious, since our Journal had reached a size in 1940 which was unwieldy when bound in a single volume and some consideration was given at the time to a suggestion that two volumes a year be published.

Future plans. It has been intimated by some Association members engaged in industry that the JOURNAL OF DAIRY SCIENCE does not meet the needs of the dairy industrialist. Their criticism is that the Journal is too academic, being primarily designed to meet the needs of the research worker rather than the practical man. This criticism cannot be ignored if Association membership is to be encouraged among industrial dairymen.

Traditionally the JOURNAL OF DAIRY SCIENCE is a research journal, and if its present scientific standing is to be maintained, it must continue to be a research journal. The publication of abstracts and review articles was undertaken with the primary purpose of making a stronger appeal to the busy industrialist. It would appear from comments reaching the editor that these ventures are not fully serving the purpose primarily intended.

This problem presents a challenge to our association. It deserves thorough investigation and careful study by the Journal Management Committee. We trust that any plans evolved will: (1) Assure the Scientific standing of the JOURNAL OF DAIRY SCIENCE. (2) Supply a type of publication service which will meet the needs of the practical dairyman.

Acknowledgment. Again we gratfully acknowledge the generous assistance of a host of loyal workers whose help makes possible the publication of the JOURNAL OF DAIRY SCIENCE.

Mr. P. H. Tracy moved and Mr. W. E. Petersen seconded that the Editor's report be accepted.

SECRETARY-TREASURER'S REPORT

Secretary Stoltz then read the following report:

Membership and Circulation

The circulation of the JOURNAL OF DAIRY SCIENCE in the year 1944 was one of the highest of our experience. We had 1388 members, which was exceeded only in 1939 and 64 more members than we had in 1943. The following table of members, subscribers, associate subscribers, and student affiliates tells this story:

Circulation of The Journal of Dairy Science
December 31, 1944

	Members	New members	Subscribers		Associate subscribers	Student affiliates	Total
			Domestic	Foreign			
1937	928	.....	360	385	110	30	1813
1938	1101	332	352	395	125	81	2054
1939	1465	419	321	385	73	156	2400
1940	1339	105	331	360	62	283	2375
1941	1321	103	353	316	66	391	2447
1942	1276	100	371	212	49	235	2143
1943	1324	134	463	208	85	108	2188
1944	1388	111	519	233	81	45	2377

The domestic subscribers reached the highest in our history. We have had a loss in 1944 compared with 1943 in obtaining new members, student affiliates, and associate subscribers. Student affiliates and foreign subscribers, will not increase until after the war, but the total circulation for 1944 is almost 189 higher than it was last year. This year we have had 2600 Journals printed, and it's very likely we'll not have sufficient to have a reserve of 200 copies as we generally plan to order. We trust that the paper shortage next year will have improved to such an extent that we can increase our order of Journals.

Our loss in membership amounted to 68, which is approximately 5 per cent. The following data show our loss and gain in members:

Membership, December 31, 1943		1324
Gain: New Members, 1944	112	
Former Student Affiliates	20	
Total Gain	132	
Loss: Members resigned and delinquent for 1944:		
Delinquent	39	
Resigned	14	
Deceased	7	
Servicemen	8	
Total Loss	68	
Net gain in membership		64
Membership, December 31, 1944		1388

As reported last year, we are expecting our circulation to reach 3,000 after the war. We trust that each of our members will be on the alert for new readers, especially those who have students under their jurisdiction. Those in the military service who had previously been student affiliates may become active members without paying an affiliation fee.

Back Copies

During the past year we have sold a minimum of 16 sets of each volume of all the back Journals. The income was $2,240.50. We are having 9 issues reprinted and it will be up to the Executive Committee to decide whether or not some 10 complete volumes should be reproduced in order to supply our members with all the back copies.

Advertising

Our advertising income is still on the increase. In 1943 we sold 171 pages which was higher than any previous year. In 1944 we sold 190 pages. Our advertising sold for the first five months of 1945 is equal to 1944. We are pleased to take this opportunity to again express our gratitude to the companies that use our pages for advertising. Any courtesies shown these advertisers will be much appreciated.

Financial

The income for 1944 amounting to $21,696.38 is the largest income of any year during our organization. Our expenditures amounted to $18,758.97, leaving an operating profit of $2,937.41. As of December 31, 1944, our net worth was $26,080.97. We had an investment in government bonds of $22,108. A complete report of the Certified Public Accountant was sent to each Director and Officer March 6, 1945.

The Secretary-Treasurer wishes to take this opportunity of expressing his gratitude and thanks to the officers and members for the splendid cooperation that has been received.

Mr. P. H. Tracy moved that college students receiving salaries not in excess of $1,000 be eligible to Student Affiliation in the Association. The motion was seconded by Mr. C. L. Blackman and carried by vote.

Mr. Blackman then gave the report of the Auditing Committee as follows:

May 29, 1945

Directors and Members of the
American Dairy Science Association

Gentlemen:

The Auditing Committee of the American Dairy Science Association met with Mr. Walter C. Burnham, the certified public accountant who examined the financial statement of the Secretary-Treasurer of the American Dairy Science Association. The Committee met with Mr. Burnham in Columbus on May 28, 1945.

Mr. Burnham stated that he had made a careful audit of the accounts, checked the bank statement and reconciled the checking account. He also stated that he counted the bonds held by the Association.

After conferring with Mr. Burnham, the Committee is satisfied that the statement submitted by the Secretary-Treasurer is correct. We recommend that it be accepted by the Board of Directors and the members of the American Dairy Science Association.

Respectfully submitted,

C. L. Blackman, *Chairman*
O. F. Garrett
Ivan McKellip

Upon motion duly seconded it was accepted.

Upon motion duly seconded the Secretary was authorized to have reproduced the January number of Volume XVI, 1933; January and September numbers of Volume XVII, 1934; and the January, February, March, April, May, and July numbers of Volume XXII, 1939. Mr. A. C. Dahlberg moved and Mr. J. A. Linn seconded that the report of the Secretary-Treasurer be accepted.

The budget for the following year was made by the Executive Committee as a whole. Mr. P. H. Tracy moved and Mr. J. A. Nelson seconded that the budget as prepared be approved.

Mr. C. L. Blackman moved and Mr. A. C. Dahlberg seconded that R. B. Stoltz be re-elected Secretary-Treasurer, and T. S. Sutton be re-elected Editor for the year 1946.

Mr. Glenn Salisbury, Chairman of the Production Section, gave the following report:

Breeds Relations Committee Report

A committee on Uniform Rules for Official Testing has been working with the Purebred Dairy Cattle Association since 1941. The first committee meeting held in April, 1941, submitted recommendations covering 20 items in the rules for the conduct of Advanced Registry tests and 13 items in the Herd Test rules. These recommendations were reported at the 1941 annual meeting of the Purebred Dairy Cattle Association and were submitted to each of the five dairy breed associations for consideration.

A second meeting was held in January, 1942, and further consideration was given to items from the previous report that were questioned or objected to by any of the breed associations; and other items including the matter of terminology to be used in designating tests according to age of cow, frequency of milking, etc., were given attention. These latter points were much more difficult of solution because of the long years of usage by the various associations and the publication of these terms in the production record volumes. The report of this meeting of the committee was approved by the Purebred Dairy Cattle Association at its 1942 annual meeting in New York in January and referred to each of the five member organizations for approval and adoption, and also to the American Dairy Science Association.

It was considered by the American Dairy Science Association at the 37th annual meeting held at East Lansing, Michigan, June 25, 1942, and the rules as applied to Advanced Registry testing were approved and adopted. Exception was taken to two items in the proposed rules for Herd Testing, namely the rules regarding "Surprise Tests" and "Figuring Herd Averages." The changes proposed by the Breeds Relations Committee to the American Dairy Science Association were later adopted by the breed associations.

At subsequent meetings of the committee held in January, 1943, and February, 1944, reports presented showed general acceptance for the most part by the breed associations, the greatest difference still being in terminology used to designate ages and frequency of milking in the published reports and in the question of exemption in the Herd Improvement test.

At the 1944 annual meeting of the Purebred Dairy Cattle Association a request was made that a joint committee representing the American Dairy

Science Association and the Purebred Dairy Cattle Association be appointed to prepare uniform rules which could be used by all breed associations. The Chairman (H. A. Herman, Missouri) and Secretary (Floyd Johnston, Iowa) of the Breeds Relations Committee represented the American Dairy Science Association.

Attached is a copy of the Uniform Rules for Official Testing—a report of the committee. These rules amalgamate the rules recommended by the Purebred Dairy Cattle Association with those adopted by the American Dairy Science Association and show the points of difference (in italics) from the rules (in January, 1945) of each of the five breed associations. They have been submitted to the executive committees of each of the breed associations for approval. They have also been reviewed by the state Superintendents of Official Testing and Heads of Dairy Husbandry Departments.

The Breeds Relations Committee recommends for adoption these Uniform Rules for Official Testing with the following changes which have been suggested to and approved by the committee:

1. That item 16B, "Percentage of Butterfat," pages 12 and 13 be changed to read as follows:

"B. Percentage of Butterfat: Should the per cent fat during any AR Test period, except the first, vary more than 1.5 (*i.e.*, from 4.0 per cent to 5.6 per cent) above or below the average of the preceding and succeeding tests (the average to be found by dividing the total fat by the total milk) *it shall be rejected* and such average used instead. *If the test for the first month of a record varies more than 1.5 per cent from the next following test, the average of these two tests shall be used in computing butterfat credits for the first month of the record.*"

2. That item 15, "Surprise Tests," page 19 be changed to read as follows:

"15. Surprise Tests. One or more surprise tests with a preliminary dry-milking may be made by a different supervisor during the testing year. Surprise tests *may* be ordered at the discretion of the breed association Superintendent of Advanced Registry, *or the state Superintendent of Official Testing* and it shall be left to the discretion of the breed association Superintendent of Advanced Registry as to whether the surprise test be in addition to or supplant the regular test.

"The first surprise test is to be at owner's expense, others at the breed association's expense."

Respectfully submitted,

H. A. HERMAN, Mo., *Chairman*
LYNN COPELAND, Ky.
E. C. SCHEIDENHELM, N. J.
K. L. TURK, N. Y.
W. W. YAPP, Ill.
FLOYD JOHNSTON, Iowa, *Secretary*

Note: The Brown Swiss Association informed the Secretary of the Committee that it adopted unanimously the uniform rules with the 2 changes noted above. Word from the states indicates almost unanimous approval. When all associations act on them it is intended that the Purebred Dairy Cattle Association will print a supply for use in all the states with a by-line approval of the American Dairy Science Association. One such rule book would replace the 7 or 8 now in use.

Mr. W. E. Petersen moved and Mr. R. B. Becker seconded that the report of the Production Section as relates to the Breeds Relations Committee be adopted.

Section Chairman Salisbury then read two program reports: (1) Feeds Relations Committee report, and (2) Report of the Pasture and Roughage Committee. Mr. W. E. Petersen moved and Mr. A. C. Dahlberg seconded that these two program reports be accepted and placed on file.

The following report of Mr. Floyd Arnold, Chairman of the Extension Section, was then submitted:

The Extension Section has ten standing committees. Four of them work jointly with Production Section Committees. Appointments run for three years. Following the annual meeting each year, the incoming chairman of the section makes all new appointments. The objective or work of committees is the solution of current pressing problems. During the year—July, 1944, to July, 1945—several committees have worked hard and they have accomplished a great deal. In this report, attention is called to the efforts of four of the ten committees.

Dairy Cattle Breeding Committee. This committee works jointly with a Production Section Committee, and C. L. Blackman, Ohio, is the chairman. To develop its program of work, a meeting of the committee was held in Chicago during the first week of December, 1944, at the time of the Society of Animal Production meetings. The principal undertaking at that meeting was a revision of recommendations for "The Organization and Operation of Artificial Breeding Associations." There is great need for this material in most every state and the work of the committee will be greatly appreciated. When completed, the revised recommendations will be made available.

Breed Relations Committee. This is also a joint committee of Extension and Production sections. H. A. Herman, Missouri, is the chairman. During the year, in cooperation with a committee of the Purebred Dairy Cattle Association, this committee prepared a uniform set of rules for official testing. The Purebred Dairy Cattle Association approved the rules of its annual meeting in January, 1945, and each breed association is expected to adopt them. Copies of the rules were printed for colleges and university representatives in charge of official testing, breed association officials, and

others interested. It is certain that when these rules are put into effect definite progress will have been made.

Testing Committee. J. F. Kendrick, Bureau of Dairy Industry, chairman. In a three-day meeting in Washington, D. C., on January 25, 26, and 27, 1945, a three-phase program was undertaken by the committee. The three phases are:

1. Revision of D.H.I.A. Herd Book.
2. Curricula for Supervisor Training Course.
3. Standard Testing Equipment.

On a separate page, attached to this report, a detailed report of the Washington meeting is given. The committee intends to make regular reports on the progress of its work to the Extension Dairymen in all states. Again, the efforts of this committee will prove invaluable.

Dairy Farm Management Committee. R. G. Connelly, Virginia, chairman. A meeting of this committee was held on October 10, 1944, in Washington, and consideration was given to the problem of farm management from the standpoint of the management of the capital investment, management with respect to crop production, management of the dairy herd, labor management, the principles in choosing enterprises on the farm, and a study of guides in choosing dairy markets. The committee was vitally concerned with the problem of adjusting dairy farm operations to meet the long-time demands of dairying. They also gave special thought to possible ways of integrating the various phases of dairy farming to provide a basically sound and balanced farm enterprise.

Reports were not available from all the committees, but it is obvious that if the 1945 annual meeting could have been held, those present would have profited much from the discussion of committee reports. The personnel of the ten Extension Section Committees for 1944–45 was announced in the January, 1945, issue of the JOURNAL OF DAIRY SCIENCE.

Upon motion from A. C. Dahlberg, seconded by J. W. Linn, this report was accepted and placed on file.

The Necrology Committee, consisting of J. R. Dice, J. H. Hilton, and W. B. Combs, chairman, submitted the following report, and upon motion by Mr. R. B. Stoltz, seconded by Mr. A. C. Dahlberg, it was accepted to be placed in the Proceedings:

The Necrology Committee regretfully report the following members as having passed away during the past year:

W. D. Dotterrer died September 25, 1944. He had been an employeee of the Bowman Dairy Company of Chicago, Illinois for 26 years.

James R. Dice, Chairman of the Department of Dairy Husbandry and assistant to the Dean of Agriculture and Director of the Experiment Station of the North Dakota Agricultural College, died May 18, 1945.

Mr. Dice was born July 6, 1887, at Enon, Pennsylvania, and was graduated from Michigan State College in 1908. He received his Master of Science degree from the University of Missouri in 1919. He was chairman of the Department of Dairy Husbandry of the North Dakota Agricultural College from 1920 to 1945.

L. C. Johnson died in Moravia, New York, November 6, 1944. Mr. Johnson had spent his business life in the dairy and dairy equipment industries, beginning with an apprenticeship in cheese making early in his career. On October 15, 1910, Mr. Johnson became associated with the De Laval Separator Company as territorial representative. He was in the employ of this firm at the time of his death.

Thomas M. Olson died at Brookings, South Dakota, on October 24, 1944. Mr. Olson was professor of Dairy Husbandry and head of the Dairy Department of the South Dakota State College at Brookings, South Dakota, at the time of his death. He was born in Sawyer, Wisconsin, October 28, 1884. He received his B.S. degree in 1915 from the University of Wisconsin and his M.S. degree in agriculture at the Iowa State College in 1920. In 1920 he was an instructor in dairy husbandry at the South Dakota Agricultural College and was made head of the dairy department of that institution in 1924.

Leonard Tufts died on February 19, 1945, at the age of 75. Mr. Tufts was president and director of the Ayrshire Breeders Association, the Carolina-Virginia Ayrshire Association, and the North Carolina State Fair Association.

William F. Epple, Assistant Dairy Chemist at Purdue Univesity, died December 2, 1944. Mr. Epple was born in Detroit, Michigan, July 16, 1881. After graduating from Purdue University in 1906, he was employed by Purdue University and was Assistant in Dairy Chemistry in the Dairy Department at the time of his death.

John W. Richardson, salesman for the Northrop, King & Co., of Minneapolis, Minnesota, died at the age of 31 in St. Louis, Missouri, June 28, 1944. Mr. Richardson was born February 4, 1913.

Thomas C. MacDonald was born in Mineral City, Ohio, October 4, 1895, and died in Chicago, June 7, 1944. Following graduation from Ohio State University, Mr. MacDonald was employed by Telling-Belle Vernon Company, of Cleveland, Ohio, where for many years he was in charge of the laboratory. In 1939 he joined the staff of the research department of the Cherry-Burrell Corporation.

C. E. Gray, former president and chairman of the board of Golden State Co., Ltd., of San Francisco and chairman of the Executive Committee of the American Dry Milk Institute, Chicago, died at his home in Oakland, California, on September 19, 1944. Mr. Gray was born May 16, 1881, on the family farm at Columbus Junction, Iowa. He was a graduate of the

Iowa Agricultural College where he received a degree in chemistry in 1901. He is best known for his interest in the dry milk industry. He is credited with being one of the founders of the American Dry Milk Institute which was founded in 1925. At the time of his death Mr. Gray was acting as advisor to the Dairy Branch of the War Food Administration, Washington, D. C.

The Secretary then reported that action had been voted by the Executive Committee since the last annual meeting: (1) Shall the report on the activities of the National Research Council be printed in the JOURNAL OF DAIRY SCIENCE? By mail vote it was rejected by 7 to 4 due to the fact that the report is somewhat similar in nature to an Association Committee report, which is published in the Proceedings; (2) That $2220 be invested in Government bonds; (3) To pay expenses of the Executive Committee meeting; (4) To publish the "Final Report of the Sub-Committee on the Determination of the Percentage of Fat in Buttermilk, Skim Milk and Whey"; (5) Voted unanimously to publish a two-page memoria of Wilbur J. Fraser (deceased), founder of the American Dairy Science Association.

The meeting then adjourned until Wednesday morning at 9 A.M.

AMERICAN DAIRY SCIENCE ASSOCIATION PRESENTED BORDEN AWARDS TO G. M. TROUT AND GLENN W. SALISBURY

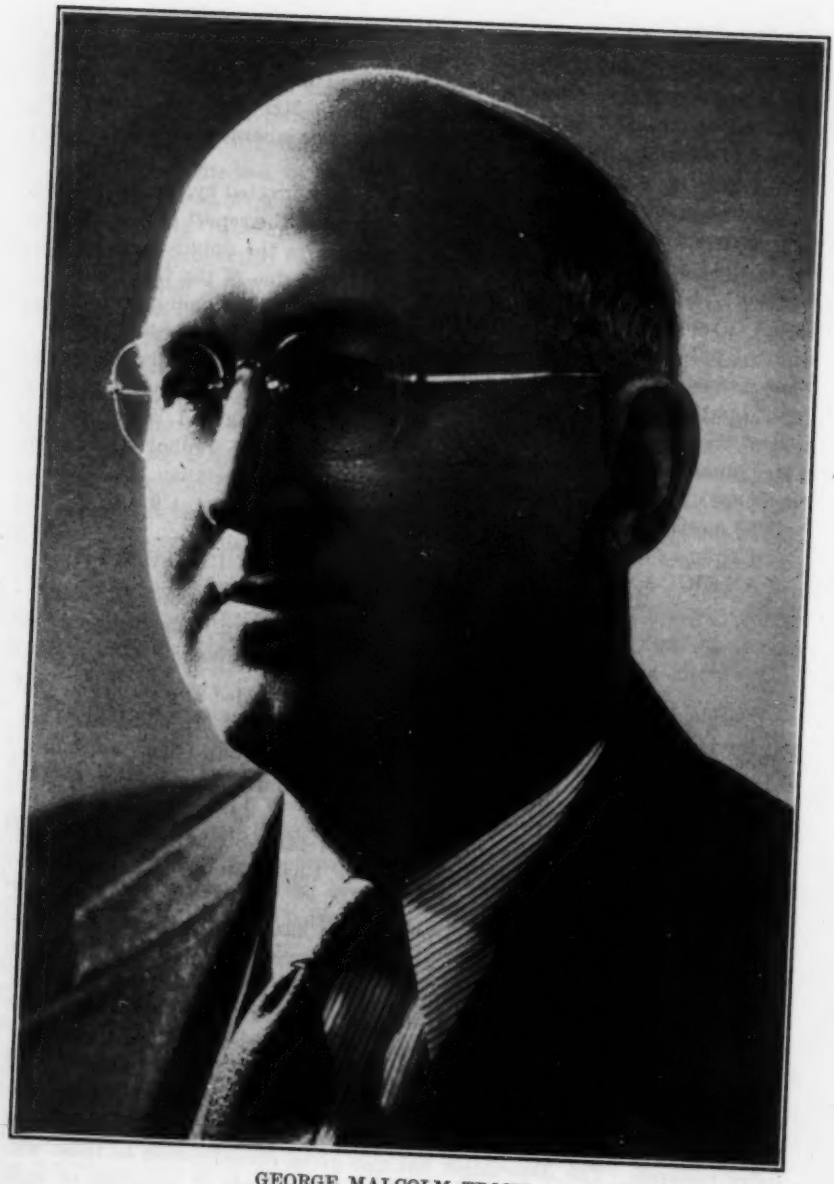
Chicago, Illinois, June 12, 1945

President A. C. Ragsdale, of the Association, presided at a dinner at the Palmer House at 6:30 P.M. on Tuesday, June 12, 1945. In addition to all of the members of the Executive Committee, G. M. Trout, Glenn Salisbury, the recipients, Manly Mumford, L. C. Bletzer, and Oliver Smaha, of the Borden Company, were present.

President Ragsdale then introduced Secretary Stoltz, who made the following statements for Dr. C. L. Roadhouse, Chairman of the Dairy Manufacturing Borden Award Committee:

"The value of research in scientific fields has been increasingly recognized by industry during recent years. The investigational work that has been done in our agricultural colleges has contributed enormously to the progress of dairying and no doubt it is in recognition of this fact that the Borden Company originally decided to make available this valued award.

"This is the ninth successive year that the Borden Company has offered awards to the American Dairy Science Association to be presented to individuals selected by the Association in recognition of accomplishments in dairy research. The Association has also given consideration to those who have made improvements in equipment and methods of handling of milk and cream and the production of milk products.



GEORGE MALCOLM TROUT

"Originally the recipients of the Borden Award were proposed by a nominating committee which reported to the Awards Committee, but in recent years, every active member has been encouraged to make nominations.

"This year the Dairy Manufacturing Awards Committee received several nominations of productive candidates who are worthy of recommendation. One of the nominees, however, has been selected unanimously by the Committee and his accomplishments have been outstanding. He and his colleagues have published fifty-two scientific papers and popular articles within the past five years.

"The recipient of the award this year is engaged in teaching and research in dairy manufacturing at Michigan State College. He was graduated from the Iowa State College in 1923 where he specialized in Dairy Industry. He continued his studies there and received the M.S. degree in 1924. He served as instructor in dairying at the University of West Virginia from 1923 to 1927 and as Assistant Professor from 1927 to 1928. He joined the Dairy Manufacturing Staff of Michigan State College at East Lansing in 1928.

"In 1935 he became a Clinton De Witt Smith Fellow at Cornell University from which institution he received the Ph.D. degree in 1936. He returned to Michigan State College and was advanced to Associate Professor in 1937 and Professor and Research Professor in 1941. He has been an energetic research worker and an enthusiastic teacher. His best-known contributions have been to studies of the effect of homogenization on the quality, flavor and some of the physical and chemical properties of milk, and the factors influencing the stability, quality and flavor of frozen sweet cream.

"The Committee is pleased to announce Doctor George Malcolm Trout of Michigan State College as the recipient of the Borden Award in Dairy Manufacturing for 1945."

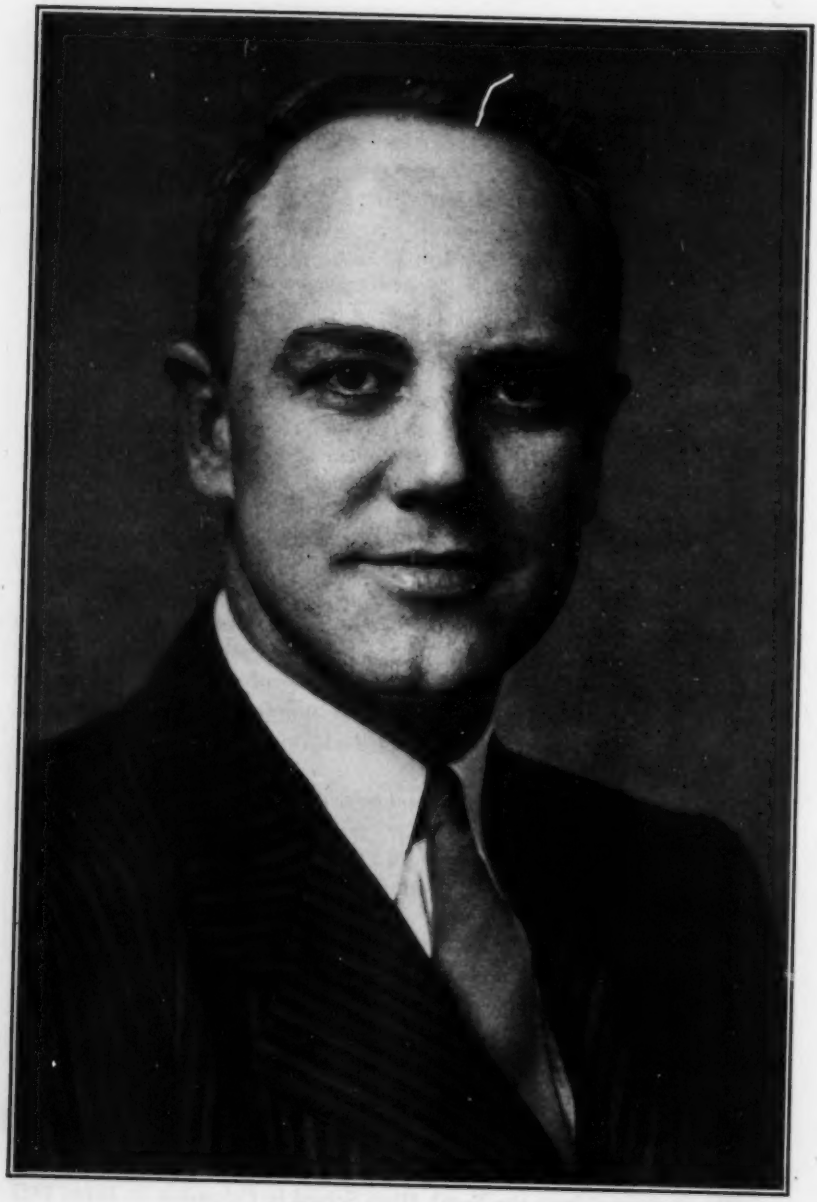
Mr. Bletzer was then introduced and presented to Mr. Trout a gold medal and $1,000.

President Ragsdale then introduced Director C. L. Blackman, who read the following statement for C. Y. Cannon, Chairman of the Borden Award Committee for Dairy Production:

"From a group of strong nominees for the Borden Award made through the Production Section of the American Dairy Science Association, the Committee was unanimous in its selection of Dr. Glenn Wade Salisbury of Cornell University for this honor.

"Dr. Salisbury was born on a farm in Sheffield Township, Ashatabula County, Ohio, June 2, 1910. His birthright stemmed not only from farm surroundings but early in life his father must have taught him that the laboratory and not the forum was the place to uncover truth. He has pursued this search for truth relentlessly.

"He graduated from the North High School in Columbus in June, 1927, and entered the Ohio State University the September following, where he



GLENN WADE SALISBURY

obtained his Bachelor of Science degree in June, 1931. Cornell University immediately invited him to be an assistant in the Department of Animal Husbandry, where he obtained his degree, Doctor of Philosophy, in June, 1934, majoring in Animal Husbandry and with minors in Nutrition and Genetics. He became Instructor in the Animal Husbandry Department in 1934, Assistant Professor in 1936, Associate Professor in 1940, and Professor in 1944.

"In the summer of 1937, Dr. Salisbury visited the British Isles, France, Jersey and Guernsey, and, in the summer of 1938, many of the state experiment stations, especially to study their research and to observe methods of breeding and management of dairy cattle.

"Dr. Salisbury also spent the summer term of 1941 at Iowa State College in post-doctorate studies in Animal Breeding and statistical methods. He is a member of the following honorary fraternities: Sigma Xi, Gamma Sigma Delta, Alpha Zeta and Phi Kappa Phi.

"The first research contribution with which Dr. Salisbury was associated had to do with determining whether timothy hay could be made a satisfactory roughage for dairy cattle by a combination of nitrogen, fertilization and early cutting. This was followed by a series of experiments to determine whether normal milk flow and body weight could be maintained by good dairy cows when fed most non-legume roughage and a concentrate mixture made up of mostly corn and corn by-products, which supplied poor quality protein.

"During the last five years his research work has been in the field of breeding, especially emphasizing factors related to artificial insemination. Here, his contributions have been especially valuable. Many new facts have been uncovered which have made artificial insemination more usable, permitting its spread more widely among dairy cattle breeders.

"Dr. Salisbury suggested improvements in the artificial vagina which permitted control of temperature during semen collection under all weather conditions. He demonstrated, that for bull semen, the optimum storage temperature was dependent in a large measure upon the rate at which the semen was cooled from body temperature to temperature of storage. He developed the yolk-citrate diluter which has certain advantages over other diluters previously suggested. He has devised methods for determining quickly and accurately the number of spermatozoa in semen samples and their quality. His later work has dealt with ways of successfully diluting semen and with the effects of nutrition on bull fertility.

"During the period 1939–44 he has published, as author, senior author or co-author, 20 scientific articles, all dealing directly with fundamental problems in the dairy production field.

"Though young in years, Dr. Salisbury has attained much. We predict more brilliant contributions from him."

Mr. L. C. Bletzer of the Borden Company then presented Glenn W. Salisbury with a gold medal and a check for $1,000.

The meeting then adjourned.

President Ragsdale called a meeting of the Executive Committee at 9 A.M. at the Stevens Hotel on Wednesday morning, June 13, 1945, with the following present: President, A. C. Ragsdale; Vice-President, J. A. Nelson; Secretary-Treasurer, R. B. Stoltz; Editor, T. S. Sutton; Directors, P. A. Downs, J. W. Linn, P. H. Tracy, C. L. Blackman, R. B. Becker, W. E. Petersen, and A. C. Dahlberg.

After a brief discussion as to the policy of Sections holding elections, Mr. W. E. Petersen moved and Mr. A. C. Dahlberg seconded that the Executive Committee recommend that all Section Officers be held over for one year.

Mr. P. H. Tracy moved and Mr. P. A. Downs seconded that the invitation from Iowa State College to hold the Annual Meeting of our Association for the week of June 18, 1946, be accepted.

Mr. A. C. Dahlberg then gave the following report on the Committee on Honors or Special Recognition:

This Committee was appointed to study the problem of means of honoring members of the American Dairy Science Association with the possibility of establishing a new type of honor to be called a "Fellow." The American Dairy Science Association has apparently established the policy of honoring its members and in the past this has been done by the Executive Board on special occasions. In practice each of the living charter members of the American Dairy Science Association has been honored in some form if he had maintained his membership for a reasonable period of time. There appears to have been no uniformity as to the award of the two classifications which have been used in the past, namely "life membership" and "honorary life membership." It seems desirable, therefore, that the Executive Board should take action to establish principles which might govern the selection of future members to be honored.

The Committee on Honors therefore recommends:

I. That the present plan of honoring anyone with a life membership who has been a member of the American Dairy Science Association for at least 25 years at the time of his retirement from active duty be continued. When the secretary is notified or otherwise learns that a member is eligible for life membership, he shall recommend that the executive Committee take official action in the case and at the next regular meeting of the Association, the member shall be presented with the Association's Life Membership Certificate. Life members shall receive the JOURNAL OF DAIRY SCIENCE, if they so desire, and be exempt from the payment of dues as long as they shall live. They shall have all the rights of regular membership.

II. That a classification of honorary membership be established by the American Dairy Science Association and that the qualifications for this membership shall be as follows:

1. The person selected as an honorary member shall have been a member of the Association for not less than ten years, shall have participated in the activities of the Association and shall have rendered meritorious service to the dairy industry through contributions in research, teaching, extension, administration or commercial scientific work.
2. No more than one such honor is to be conferred during any one year.
3. Any member of the Association may nominate a candidate for honorary membership, such nomination being sent to the Chairman of the Committee on Honors, or the Secretary or President of the Association. The Committee on Honors shall consider all nominations and decide who, if anyone, shall be recommended to the Executive Board as an honorary member. Such recommendation by the Committee shall be made to the Secretary at least six weeks prior to the date of the annual meeting of the Association.
4. At the annual meeting of the Association, the honorary member shall be awarded the Association's Certificate of Honorary Membership with the announcement that during his lifetime, he will continue as an active member of the Association with all rights and privileges, including receiving the JOURNAL OF DAIRY SCIENCE, without the payment of further dues.

III. The Committee has canvassed the status of "Fellows" in most of the leading scientific societies and finds the qualifications to vary considerably. Most societies have no "Fellows." It appears obvious that the "Fellows" has no special significance as a term to designate honorary membership in any society. It is therefore the recommendation of the Committee that a class of membership known as "Fellows" not be established in the American Dairy Science Association.

IV. That the Honors Committee be composed of the last three living Presidents and the Chairman to be the one who has served the longest period on the Committee. The Committee recommends that the vote of the Executive Committee be by ballot and that it require two-thirds vote to elect anyone as an honorary member.

It is the opinion of the Committee that honorary membership in the American Dairy Science Association should be kept on a very high plane. It is felt that this will be accomplished by adhering to the requirements of honorary membership mentioned above. If at some time in the future the list of those eligible for honorary membership becomes so long that it seems wise to elect more than one honorary member per year, it will be a simple matter to amend this report.

A. C. DAHLBERG, H. P. DAVIS, H. F. JUDKINS, *Chairman*

J. A. NELSON, *President*

Mr. C. L. Blackman moved and Mr. J. W. Linn seconded that the report be accepted.

Mr. R. B. Stoltz moved and Mr. T. S. Sutton seconded that Mr. George White and Mr. Oscar Erf be elected to Life Membership.

Mr. W. E. Petersen then reported for the Committee of the Inter-Association Council on Animal Diseases and Production. Mr. W. E. Petersen moved and Mr. A. C. Dahlberg seconded that the report be accepted and placed on file.

A letter was read from Mr. Robert F. Griggs, Chairman of the Division of Biology and Agriculture of the National Research Council, concerning our request for research work pertaining to Brucellosis. Mr. R. B. Becker moved and Mr. P. A. Downs seconded that this letter be referred to Mr. W. E. Petersen, who represents this Association on the Inter-Association Council.

The Executive Committee then adjourned to visit the Subsistence Research and Development Laboratory at the Quartermaster Depot on Pershing Road. They were very delightfully entertained, and each became a member of the Guinea Pig Club.

The Executive Committee met at 2:30 P.M. in the Stevens Hotel on Wednesday afternoon, June 13, 1945, and after some discussion regarding the need of sections for our members who are in commercial work in dairy manufacturing, Mr. W. E. Petersen moved and Mr. J. W. Linn seconded that the Board authorize the formation of a Dairy Technology Section.

Mr. R. B. Stoltz moved and Mr. J. W. Linn seconded that the American Dairy Science Association resign from the Union of Biological Societies.

The Secretary then read the results of the election as follows:

Vice-President—FORDYCE ELY, Kentucky

Directors for

3 years —K. L. TURK, New York

W. V. PRICE, Wisconsin

The Secretary moved and Mr. W. E. Petersen seconded that a Committee be appointed to draw up a resolution and submit it through the Secretary to the Executive Committee for approval that the Quartermaster General be requested to increase the amount of milk consumed by the men in the Service.

A motion was duly made and seconded stating the appreciation of the services of the Editor and Secretary, to Mr. P. H. Tracy for providing meeting arrangements, to Colonel Isker of the Subsistence Research and Development Laboratory, Quartermaster Depot, and to the Borden Company for their continued interest in the encouragement of research among our members.

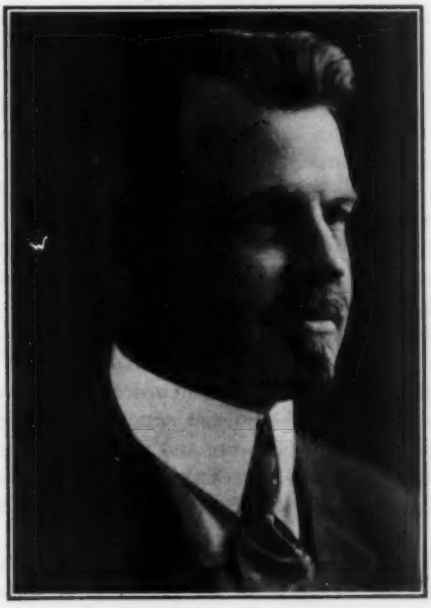
The meeting then adjourned.

WILBER JOHN FRASER

July 1, 1869 — April 16, 1945

FOUNDER OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

Wilber John Fraser, Professor of Dairy Farming at the University of Illinois, received his academic training at the institution he later served with distinction for many years. His Bachelor of Science degree was received in 1893 and his Master of Science degree in 1902. During the years 1917 to 1919, he studied agricultural economics at Harvard University. His university training was supplemented by European travel in some of the principal dairy countries and by extensive travel in this country.



WILBER JOHN FRASER

Following his graduation in 1893, Professor Fraser was employed as an assistant on the staff of the Agricultural Experiment Station. In 1896 he founded the Department of Dairy Husbandry and served as the first head of the department.

Professor Fraser's early studies dealing with the feeding and management of dairy cows led to the discovery of differences in the efficiency of

individual cows and to the belief that the selection of each cow based upon her production record is fundamental to profitable dairy farming. The studies were made not only upon the station herd but records were kept on a number of farm herds in Northern Illinois. The records kept on these farms were much like those which are now kept in the cow testing and dairy herd improvement associations, the first of which was organized a few years after Professor Fraser's pioneer work. The findings of these studies were widely publicized in bulletins and circulars of the experiment station. The late Professor Eckles in his text book, "Dairy Cattle and Milk Production," credited the Illinois Station with being the first to call to the attention of the public the importance of the selection of the individual cow.

At the time Professor Fraser took his academic training there were comparatively few scientific data available with respect to milk production. His search for knowledge led him to seek the counsel of others in the field and this prompted him to invite for a conference at the University of Illinois a number of dairy teachers and investigators. At this meeting, which was held on July 17, 1906, an organization of dairy instructors was founded. Later this organization became the American Dairy Science Association. Professor Fraser's initiative in bringing about the establishment of this Association was recognized through the presentation of a scroll to him during the annual meeting of the Association in 1933.

The formation of the American Dairy Science Association was described by Professor Fraser at this meeting. A portion of his address and a picture of the first members of the Association are published in the JOURNAL OF DAIRY SCIENCE, Volume 16, pages 582 and 583.

Professor Fraser became widely known in Illinois and surrounding states as a result of his public addresses and experiment station publications, and his sphere of influence was greatly widened through his contributions to *Hoard's Dairyman*. These widely read articles helped to promote the extensive use of sweet clover for pasture and the use of other legume forages, particularly alfalfa hay, in dairy cattle feeding. He was the author of "Dairy Farming," "Profitable Farming and Life Management," and "Dairy Profit."

Mrs. Fraser survives her husband as do their two children, Cecil E. Fraser, Assistant Dean of the Graduate School of Business Administration at Harvard University, and Miss Gladys Fraser, who is in the Child Welfare Division of the Public Welfare Department of the State of Indiana. Students of this good man carry pleasant memories of the hospitality of his home.

The highest tribute that can be paid the founder of the American Dairy Science Association is the love and honor in which he was held by every one who knew him.

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United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEW

246. The Artificial Insemination of Farm Animals. ENOS J. PERRY AND OTHERS. Rutgers University Press, New Brunswick, New Jersey, May 1945. 265 pages, illustrated. Price, $3.50.

This book is written in popular style. It should be of interest to livestock breeders, teachers, and students as well as those working in the field of artificial breeding as inseminators and technicians.

A short chapter is devoted to the development of artificial insemination. The chapter on the organs of reproduction of farm animals gives a good background for an understanding of the possibilities and limitations of artificial insemination.

Considerable space is given to a discussion of procedures and techniques essential for securing satisfactory conception rates. One chapter is devoted to artificial insemination as it applies to each class of farm livestock including cattle, sheep, horses and jack stock, swine and poultry.

There is also a brief discussion of breeding better livestock and the selection of sires. The chapter on cooperative artificial breeding associations gives a detailed discussion of the development and operation of these associations in the United States. C. L. BLACKMAN

BUTTER

247. New Zealand Creamery Costs and Pay-Outs for the 1937–38 Season. J. F. TASKER, Dairy Res. Inst., Palmerston North, New Zeal. New Zeal. Jour. Sci. and Technol., *26A*, No. 4: 204–213. Dec., 1944.

The larger the creamery, the less were the total manufacturing costs per pound of butterfat, and the higher was the rate of payment to the patrons. W.C.F.

248. Acidity: Its Relation to Butter Flavor. A. H. WHITE, Div. Dairy Res. Dept. of Agr., Ottawa. Sci. Agr., *25*, No. 3: 137. 1944.

Samples of sweet cream were cultured with lactic starter in such a way as to secure creams of varying acidities. Samples of sour cream were also secured. These were then neutralized and pasteurized with the result that the treated creams before churning had average acidities of 0.116, 0.203 and 0.310 per cent. Butter samples were held for periods ranging from 127 to 203 days at temperatures of 12° F. and −10° F.

"The acidity of the cream and therefore the pH of the butter serum, was found to have a definite effect on the flavor scores of the butter. As the

average acidity of cream was increased from 0.11 to 0.20 or 0.31 per cent, the average pH values of the butter serum decreased from 6.76 to 6.1 and 5.51 respectively with a resulting loss in flavor scores of the butter of as much as 2 to 3 points between the low and the high acid butters.

"In the medium and high acid butters, the principal flavor defects noted were of a metallic, sour or acid, and in one case, of a fishy nature. The data indicated that the acidity of neutralized sour cream should be adjusted to 0.15 per cent or lower to give a pH in the butter serum of 6.7 to 7.2 if the highest flavor scores are to be obtained on the butter when fresh and after storage." O.R.I.

249. The Manufacture of Butter from Sour Cream. EMERSON W. BIRD, Iowa State Col., Ames, Iowa. Natl. Butter and Cheese Jour., *36*, No. 5: 34, May, 1945, and No. 6: 29, June, 1945.

This detailed description of handling sour cream in butter making consists of specific instructions and calculations which should be of interest to the creamery operator. These details cannot be condensed with accuracy but must be read in full to be most useful. Acid-reducing agents are of the "lime" or "soda" types. Each agent has an acid-reducing power which is fairly constant. These agents may be used alone or in combinations. Regardless of the type of acid-reductant, best results are obtained when the butter serum has a pH of 6.6 to 7.2. Soda type reductants yielded less undesirable flavors than did lime types; dolomitic lime seemed better than calcium lime. Soda ash is the most economical of the soda compounds but the limes are more economical than the soda types. When selecting an acid-reductant or combination of them, the operator must consider the acid reduction required, the vat space available to allow for foaming, the quality and keeping properties of the butter produced, and the results obtained in drying the buttermilk. When a satisfactory acid-reducing agent or combination has been chosen on the basis of these considerations, it is not advisable to change. The discussion contains precautions to observe in testing, extent of neutralizing, methods of pasteurizing, calculations and general use of acid-reductants. Examples are given of charts to reduce errors in neutralizing. W.V.P.

250. Material-Balance Method for Determining Losses of Butterfat in the Creamery. M. MORTENSEN. Res. Bul. 337. Iowa State Col., Ames, Iowa. 1945.

This study was carried out for the main purpose of determining what constitutes a fair overrun in the manufacture of butter. Certain causes for low overrun were also noted. Twenty-four plants using coil vat pasteurizers averaged 22.03% overrun while three using vacreators averaged 21.21%. Miscellaneous losses were not considered in figuring these overruns. In the

plants using coil vats 1.39% of the total butterfat received was lost in the buttermilk while the loss was 1.98% in those creameries using vacreators. The average fat content of the butter from 272 churnings was 80.43%. The overweight allowed on the butter reduced the overrun 0.56% of the theoretical. Churning cream testing 33% fat as compared with cream testing 26% resulted in a saving of 0.48% of the total amount of fat. P.H.T.

CHEESE

251. The Measurement of Some Physical Properties of Curd and Cheese During Manufacture of Cheese. J. E. CAFFYN, Natl. Inst. of Dairying. Univ. of Reading, Reading, England. Dairy Indus. *10*, No. 4: 257. April, 1945.

The author employed several instruments for measuring the physical characteristics of cheese during and after manufacture.

The pitching apparatus is employed before cheddaring to evaluate the curd firmness and gives a calculated value called the "pitching number."

A sectilometer is an instrument that measures the resistance of cheese (during cheddaring) to cutting by a taut wire cutter.

The ball compressor is an apparatus which measures the firmness of cheese in terms of the resistance of the cheese to deformation by a force applied to a metal spherical cap on the apparatus. One disadvantage of this apparatus is that, as cheese ripens, the measurements are affected by the rind of the cheese and the cheese bandage tension.

A firmness of the curd before cheddaring was found to affect the physical properties of the green cheese. The solids-not-fat content of the milk affected the "pitching value." It was also observed that moisture was unevenly distributed throughout the finished cheese. This condition gave rise to variations in values obtained at different places in the cheese. D.V.J.

252. The Addition of Whey Cream to Milk Used for Cheese-Manufacture. H. R. WHITEHEAD, Dairy Res. Inst., Palmerston North, New Zeal. New Zeal. Jour. Sci. and Technol., *26A*, No. 4: 201–204. Dec., 1944.

The incorporation of whey fat into Cheddar cheese was suggested as a war-time measure and was proved practicable; but because this fat was shipped as dry butterfat, use in cheese was not put into practice.

It was shown that enough whey cream could be introduced into cheese milk to add 6 to 27 per cent to the fat of the original milk without causing difficulties in manufacture or reducing the quality of the cheese. To insure success it was found necessary to heat the whey cream to 200° F. for 30 minutes to destroy bacteriophage before addition to the cheese milk. This milk had been flash-pasteurized at 155° F. The extra cheese yielded by the added fat amounted to about 1.2 times the weight of added fat.

During a one-hundred-day period in the Institute laboratories and during a ten-day period in a cheese factory, cheese was made successfully with addition of the whey cream from the make of the previous day. The fat added amounted to about 6–8 per cent of the fat in the cheese milk.

W.C.F.

253. Precision Control Methods Improve Cheese Quality. GEORGE E. HOLM, Bur. Dairy Ind. U.S.D.A., Washington, D. C. Amer. Butter Rev., *6*, No. 11: 372–374. Nov. 1944.

In a cheese improvement program the U.S.D.A. has stressed (1) use of pasteurized milk, (2) controlled starters, and (3) exact timing of operations. Eleven Minnesota cheese factories adopted the program. Before its adoption in 1942 for a two to six weeks' period these plants produced on the average 36.11% No. 1 cheese, 36.07% No. 2, and 27.82% No. 3. For the balance of the same year, 1942, the same plants produced under the program 86.29% No. 1 cheese, 9.35% No. 2 cheese, and 4.36% No. 3. For the first 9 months of 1943 the plants produced 99.03% of No. 1 cheese. P.S.L.

CHEMISTRY

254. Conductivity Measurements for Detection of Neutralizers in Skim and Buttermilk. S. T. COULTER, Univ. of Minn., Minneapolis, Minn. Amer. Butter Rev., *7*, No. 4: 104, 127. April, 1945.

Conductivity measurements of suspected samples of neutralized skim milk or buttermilk are useful but not infallible methods for detection of neutralizers. They are comparatively useless except for herd milk, since mastitis and some other physiological disturbances of the cow affect the test of the milk. A conductivity bridge and conductivity cell (cell constant 1.0) are required. The authors used a constant temperature of 77° F. for their trials. The formulas are given for the calculation of both the specific resistance and the conductivity. If the latter is above 55×10^{-6} the sample may be regarded as neutralized or as high in acid. Use of the test would appear to be applicable to the detection of neutralizers in dried milks as well as in skim milk and buttermilk. P.S.L.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

255. Textile Fiber from Casein. Factors Affecting the Tensile Strength. R. F. PETERSON, T. P. CALDWELL, N. J. HIPP, R. HELLBACH, AND R. W. JACKSON. Eastern Regional Res. Lab., U. S. Dept. of Agr., Philadelphia, Pa. Jour. Indus. and Engin. Chem., Indus. Ed. *37*, No. 5, 492. May, 1945.

The preparation of fibers from acid-precipitated casein with a laboratory spinning machine was studied. The principal factors investigated were pH

and viscosity of the spinning solution, composition of the precipitating bath, effects of drawoff and godet stretch, and progressive stretch during hardening. A spinning solution containing 20% protein and having a pH of 9.2 was generally used. All fibers were hardened with formaldehyde. Stretching the tow issuing from the spinnerette, either in the precipitating bath or between godet wheels in air, gave a tensile strength of about 0.7 gr. per denier. Under these conditions of stretching, the addition of aluminum sulfate to the precipitating batch containing sulfuric acid and sodium sulfate did not affect the strength of the fiber. Use of aluminum sulfate effected the subsequent simultaneous stretching and partial hardening with formaldehyde. When the latter process was operated at 85° C., a dry strength of 1 gr. per denier and a wet strength of 0.5 gr. per denier were obtained.

B.H.W.

256. Packaging. II. A Cellulose-base Container for Modified Vacuum Packing. A. H. Woodcock, Nat. Res. Lab., Ottawa, Can. Canad. Jour. Res., *23*, No. 2: Sec. F: 117. 1945.

"Films of wax-coated laminated 'Cellophane' have been shown to transmit carbon dioxide 25 times as rapidly as they transmit oxygen. Packages made from this film and gas packed with carbon dioxide produce a vacuum pack on standing." Factory, shipping, and storage trials have shown this package to be a promising one for whole milk powder. O.R.I.

257. A Simple Method of Determining the Copper Content of Milk Powder. M. Boulet and W. D. McFarlane, Macdonald Col. Quebec. Canad. Jour. Res., *23*, No. 2: Sec. B: 70. 1945.

"The procedure involves extraction of the copper by refluxing the milk powder with a solution of potassium thiocyanate in 95 per cent alcohol and determining the copper content of the extract by colorimetry with dihydroxyethyldithiocarbamic acid, after removing carotenoid pigments. A large enough sample can be used to permit visual color comparison with standard solutions of Alizarin Yellow G." O.R.I.

258. Dried Milk Powder. I. Methods of Assessing Quality and Some Effects of Heat Treatment. Jesse A. Pearce. Nat. Res. Lab. Ottawa, Canada, Canad. Jour. Res., *23*, No. 2: Se. F.: 177. 1945.

Palatability, as judged by a panel of tasters, was found to be a more precise method of assessing milk powder quality than the following objective tests: oxygen and water sorption; chlorophyll and peroxide oxygen values of the fat; browning of the powder; fluorescence values; changes in peroxidase; trimethylamine; volatile sulfur compounds and diacetyl content; solubility by centrifuging and a potassium chloride solution method;

titratable acidity; pH; congo rubin and iron numbers; foaming volume; coagulation by acid, alcohol, and rennet; dielectric constant; color intensity and color quality; refractive index; viscosity and surface tension.

Powders stored at 100° F. for seven days had a higher palatability score than those stored at 80, 120, or 140° F. O.R.I.

259. **Domestic and Export Possibilities of Whole Milk Powder.** E. M. BARKER, Rochester Dairy Co-operative, Rochester, Minn. Natl. Butter and Cheese Jour., *36*, No. 6: 44. June, 1945.

Extreme care is required to make a package high quality whole milk powder with the keeping quality to enable it to compete with Grade A fluid milk. Milk powder retains the vitamins of fluid milk but it is not always convenient to reconstitute. It is compact and easily carried or exported to areas lacking fresh milk. Its high nutritive value, uniformity and low cost favor its use but any gains made in competition with fluid milk can only be accomplished through high quality convenience and intelligent merchandising methods. W.V.P.

260. **How to Improve the Quality of Dry Buttermilk.** J. I. ORMOND, Kraft Cheese Co., Chicago, Ill. Natl. Butter and Cheese Jour., *36*, No. 5: 38. May, 1945.

Improvement in quality can be obtained by controlling the raw product and the manufacturing process and by testing the finished product for sediment and color. The best buttermilk for drying should be free of off flavors, should contain no neutralizer, and have not over 0.17% titratable acid. Rapid handling during drying is best and proper temperatures must be maintained. A No. 21 Grain Trier is excellent for sampling each barrel of powder. For grading in the plant, the Tumbler Test for sediment is adequate. Colors of samples can be compared by placing small amounts on white paper and pressing them under glass until the piles merge. Unsatisfactory barrels should be set aside. A daily composite sample of lots acceptable for moisture, fat, acidity, sediment, solubility index, flavor, odor, color, texture and bacteria count. Barrels should be marked with a code number and a record kept of all analyses. W.V.P.

DISEASE

261. **The Non-Toxicity of Milk and Meat from Ergotized Cattle.** I. J. CUNNINGHAM, I. G. MCINTOSH AND J. B. SWAN, Anim. Res. Sta., Dept. of Agr., Wallaceville, New Zeal. New Zeal. Jour. Sci. and Technol., *26A*, No. 3: 125–136. Oct. 1944.

Non-toxicity of milk and meat from ergotized cattle was demonstrated by animal feeding experiments. W.C.F.

262. The Effect of Subzero Temperatures on Hypoderma Lineatum Devill. R. W. SALT, Dom. Ent. Lab., Lethbridge, Alberta. Sci. Agr., *25*, No. 3: 156. 1944.

Warble fly larvae and pupae were subjected to low temperatures to learn the effect of this factor on their survival. Temperatures of about – 23° C. (9.4° F.) were found to be fatal. However, temperature of this severity are uncommon in the soil, manure or litter around stables and corrals. To stockmen this means that spraying as a control measure is necessary earlier in the season. Many if not all of the early dropped grubs are immature forms that are incapable of maturing. O.R.I.

ICE CREAM

263. Plant Pointers. R. J. RAMSEY, Ramsey Lab., Cleveland, O. Ice Cream Trade Jour., *41*, No. 5, May, 1945.

Formulas for war-time ice cream and sherbet are presented which will produce products of acceptable body and texture. Ice Cream: 10.00 per cent B. F., 8.00 per cent S. N. F., 7.00 per cent cane sugar, 10.00 per cent sweetose type corn syrup, or 12.00 per cent high D. E. corn syrup, 0.4 per cent 225 Bloom gelatin, or 0.5 per cent of the new stabilizers containing monoglyceride, 1.00 per cent egg solids.

Sherbet: 17.00 lbs. cane sugar, 15.00 lbs. corn sweetener, 2.00 gals. ice cream mix, 7½ oz. 225 Bloom gelatin, 10.00 oz. citric acid, 15.00–20.00 lbs. good fruit (deduct from the cane sugar figure listed above, the sugar which would normally be in the fruit used, otherwise sugar content may be too high). Color to suit the eye. Add water to make the above mixture up to 10 gals. volume. Freeze at not to exceed 40% overrun in normal times and not to exceed 50% overrun under war-time conditions.

Many plants are using corn syrup of the enzyme inverted type or the high dextrose corn syrup to replace about ¼ of the cane sugar. Dark syrups are also being used but they are not satisfactory in vanilla ice cream, however, they may be used with fair results in chocolate ice cream.

The following factors cause ice separation during the freezing process: low solids, improper stabilization, low sugar content, frozen cream and condensed milk, mix frozen on coolers, mixing two lots of different temperatured ice cream, excessive pressure in the discharge line from the freezers, oil in freezer barrel, ice cream too warm, improper homogenization, passage of ice cream through freezer too slowly, and mechanical troubles with the freezer. Caution in changing from a satisfactory stabilizer to an untried one and the use of eggs as a source of solids is suggested. W.H.M.

264. Lessons from Wartime Ice Cream Restrictions. E. C. SCOTT, Swift & Co., Res. Div. Ice Cream Trade Jour., *41*, No. 4: 26. April, 1945.

Ice cream manufacturers operating under war-time restrictions have had

to make many changes in their formulae and methods of processing. The part played by sugar and stabilizers has been more prominent than ever and has made it possible to make acceptable products even though milk solids have been limited. Good sherbets call for 28 to 30 per cent sugar, 4 per cent total milk solids and adequate stabilizer. Ageing of the sherbet mix and ample fruit for flavoring are recommended.

In the manufacture of ice cream the use of corn sugar, corn syrup solids, corn and malt syrup and wheat syrup have served not only as sweeteners but have provided extra total solids and made it possible to make smooth ice cream of good quality with comparatively low fat and solids not fat.

W.H.M.

265. Sugar, The Industry's Position. ROBERT C. HIBBEN, Ice Cream Trade Jour., *41*, No. 4: 20. April, 1945.

At a hearing before a special Congressional committee on sugar, Mr. R. C. Hibben presented a brief in which he estimated the ice cream industries' 1945 sugar requirements exclusive of dextrose at 176,626 tons for producing ice cream and other frozen products for civilian consumption. He stated that a quota of 70 per cent of the base period usage, about 100,000 tons, would be insufficient to meet the needs of the industry. W.H.M.

266. Powdered Whole Milk and Mix. P. H. TRACY, Prof. of Dairy Husb., Univ. of Ill., Urbana, Ill. Ice Cream Trade Jour., *41*, No. 4: 22. April, 1945.

"Experimental studies of dried mixes conducted at the University of Illinois justify the following conclusions regarding the manufacture of powdered mix.

"1. High preheating temperatures are important as in the manufacture of powdered whole milk. 2. If all the sugar is added before drying a caramel-like flavor will result. (Limit amount added to about 25% of total to avoid this.) 3. Most stabilizers are satisfactory for us. However, gum type products are to be preferred. 4. The concentration of solids in the mix to be dried will be limited by the viscosity as produced by the stabilizer used. If the viscosity is excessive, mix will be difficult to handle and will incorporate an excessive amount of air which will cause a high oxygen content in the powder. 5. Certain antioxidants will lengthen the life of the powder. 6. Powdered mix can be reconstituted with cold water and frozen without ageing to 100% overrun. 7. Aged reconstituted powdered mixes whip only slightly faster and produce ice creams with only slightly superior bodies as compared with the unaged mix. 8. Ice cream made from fresh powder is indistinguishable from that made from the same mix not dried. 9. Powdered mix should be gassed before shipment unless it is to be used immediately. 10. It is possible to produce powdered mixes of low bacterial

content. . . . it seems reasonable to conclude that the dried milk industry will play an important part in the utilization of any milk surplus that may exist by supplying powdered milk and mix of high quality to interested users. Powdered milk and mix will not necessarily jeopardize the present milk and mix markets for it is likely that new products of this type will be used largely to supply new markets." W.H.M.

MILK

267. The Effect of Thermophilic Organisms in Holder-Pasteurized Milk on the Reduction of Methylene Blue Dye. E. R. BIRD AND J. W. EGDELL, Univ. of Bristol, Bristol, England. Dairy Indus., *10*, No. 4: 266. April, 1945.

Raw milk supplies showed a negligible thermophilic count even after pre-incubation at 63° C. However, after normal holder pasteurization relatively high thermophilic counts were observed. This was especially true after the plant had been in operation for about three hours. Swab tests of the pre-heaters and holders demonstrated the increased development of thermophiles during this period.

While pasteurized milk of high thermophile count (63° C.) may show a low count at 37° C., it may reduce methylene blue dye at 37° C.

The authors point out that some pasteurized milk may comply with the present bacterial standards and yet contain great numbers of thermophiles.

D.V.J.

268. What About Future Deliveries? LELAND SPENCER, Cornell Univ., Ithaca, N. Y. Amer. Milk Rev., *7*, No. 3: 73, 82–85, 97–100. March, 1945.

Information contained in this article was secured by means of questionnaires sent to distributors of milk in the New York City area for the purpose of ascertaining opinion on the advisability of continuing some war restrictions as economy measures after the war. Of 209 distributors taking a definite stand on the questions asked, 89 per cent were in favor of continuing every other day delivery of milk. A majority preferred that grades of cream be limited to two, light and heavy. Suburban distributors favored daylight delivery and a ban on "call backs" to a greater extent than did city distributors. Large distributors looked with disfavor on special deliveries and use of pint bottles. The chief reason of dealers for favoring retention of some war-time restrictions is the resultant savings. A majority suggested this be accomplished by state regulation; others by industry agreements or federal regulation. In case certain war restrictions are to be retained most of those questioned were of the opinion that to be effective plans must be drawn up and adopted before the lapse of the present requirements.

P.S.L.

269. Butterfat Differentials Used in Paying Producers for Market Milk. LELAND·SPENCER AND STEWART JOHNSON. Cornell Univ., Ithaca, N. Y. Amer. Butter Rev., *6*, No. 10: 302–308. Oct., 1944.

In some major producing districts the price of extra fat in milk has remained fixed at four cents per point for several months; the basic price of milk has risen to the highest price paid in the last quarter of a century. This has penalized producers of high-testing milk. If price is based on butterfat alone a premium is set on high-test milk. The differential should be such as to insure milk of the richness demanded by the market; and such as to maintain comparative profits from high-test and low-testing herds. Energy value of milk increases 1.8% for each point increase in butterfat content and the four cent differential has been quite accurate, therefore, up to the time of war-time prices. Most markets, however, have paid higher differentials and used one or more of several methods of calculating differential. If milk tests above average an increase in differential increases its price and lowers that of milk testing less than average but it neither affects total returns to producers nor average price paid to producers. The authors believe the differential paid should be 1.5 to 1.8 per cent of the base price for 3.5% milk, and that a rising and falling differential scale is necessary if present fat content of market milk is to be maintained. A low, fixed differential encourages production of low-testing milk. P.S.L.

270. Dairy Arithmetic Made Easy. PROF. L. C. THOMSEN, Univ. of Wis., Madison, Wis. Natl. Butter and Cheese Jour., *36*, No. 5: 42. May, 1945.

There are only four special calculations necessary to solve most dairy problems. These are: 1) To find the per cent of a quantity; 2) To find what per cent one quantity is of another; 3) To find a number of which another number is a certain per cent; 4) To find an unknown number when its value in relation to three known numbers can be stated as a proportion. Formulas are listed and examples are given for calculating: depreciation, solids-not-fat, casein, adulteration of milk by watering and skimming, use of lactometer, subsidy problems, and payments for milk on fat and solids-not-fat basis. W.V.P.

271. Factors Affecting Can Washing. V. SCHWARZKOPF. Lathrop-Paulson Co., Chicago, Ill. Natl. Butter and Cheese Jour., *36*, No. 5: 27. May, 1945.

Best results in can washing can be obtained by observing a few factors. Adequate steam and water supplies must be provided at reasonably uniform pressures. Proper temperature controls are essential. Wash water should be maintained at 150° F., volume rinse and sterile rinses at 215°–230° F.,

and hot air for drying at 240°–270° F. Water should be treated to prevent lime deposits, adjusted to pH 6.8–7.8, and continuously replaced to prevent excessive pollution. Hydrochloric and phosphoric acids, even with inhibitors, are not safe for can washing. Keep the can washing machine clean and well ventilated between operating periods. W.V.P.

PHYSIOLOGY

272. Apparatus for the Measurement of the Rate of Milk-Ejection in the Dairy Cow. W. G. WHITTLESTON, Anim. Res. Sta., Dept. of Agr., Wallaceville, New Zeal. New Zeal. Jour. Sci. and Technol., *26A*, No. 5: 252–257. Feb., 1945.

The apparatus is designed so as to not affect the cow's environment during milking and hence the milk being measured will not alter in any way the action of the milking machine. The author claims that it is simple enough to be operated by the ordinary worker and is almost automatic. It is equipped with a recording device that graphs pounds of milk against time. The construction as described is much less simple than the operations. W.C.F.

MISCELLANEOUS

273. Destroying Air-Borne Bacteria. Anonymous. Natl. Butter and Cheese Jour., *36*, No. 5: 41. May, 1945.

Special ultra-violet lamps of the cold cathode, low pressure, mercury-vapor arc type for A.C. operation only, may be used in the dairy industry for destroying air-borne bacteria. Possible installations are in barns, utensil storages, pasteurizing rooms, churn rooms, and cheese factories. W.V.P.

274. Some Studies on the Properties of Rubber Used in Dairy Equipment. Part I. W. A. WHITTLESTON, Anim. Res. Sta., Dept. of Agr., Wallaceville, New Zeal. New Zeal. Jour. Sci. and Technol., *26A*, No. 5: 223–252. Feb., 1945.

Studies were made on the accelerated ageing of rubber, the testing of rubber tubing, the influence of butterfat on such properties of rubber as tensile strength, heat-ageing resistance and light-ageing resistance, and methods of conservation of rubber, the last-named to appear in a future installment. Methods for testing physical properties and expressing results are described. W.C.F.

275. Personnel Relations. J. E. WATTERS. The Ronald Press Company, New York. 1945.

The author, a personnel relations consultant, formerly Vice President in charge of personnel and labor relations of Revere Brass and Copper Incorporated, and one time Director of Personnel, and Professor of Personnel

Administration at Purdue University, has drawn upon a wealth of experience in the preparation of his book and he has presented an interesting and readily understandable exposition of a subject which has become an increasingly important and vital operational phase of both large and small businesses. Wherever the employer-employee relation exists personnel problems arise and require solution and often the most meticulous handling. Human nature being no different now than it ever has been requires careful consideration by management when dealing with its working force. The larger a business becomes whether it be a heavy industry manufacturing plant, a chain store organization, a city milk plant, an ice cream concern, or a large coooperative dairy, personnel administration assumes a major responsibility in the organization's successful functioning. The results of experience set forth by Mr. Watters should enable many company executives to formulate and put in force personnel methods fitted to their individual situations or to strengthen existing departments of this sort.

The relationship of employer and employee in the present day industrial world has become vastly complex through a multiplicity of laws dealing with labor and social security and in this book the author has given these items clarifying treatment. Democracy in industry is a keynote in the book which is divided into five parts.

Part I: Workers as Determinants of Personnel Relations; Part II: Management of Personnel Relations; Part III: Personnel Relations Technique; Part IV: Governmental Cooperation With and Regulation of Personnel Relations; Part V: Union-Management-Government Cooperation. In an appendices section a short treatment is given of Statistics in Personnel Relations; a sample Periodic Personnel Audit Report; Selected General References on Personnel Relations, grouped under the headings: A. General References. B. From the Economist's Point of View. C. Psychological. D. Labor. E. Industrial Management. F. Government. G. Periodicals. Also is included a detailed reference list selected specifically to each of the twenty-two chapters of the book. Throughout the book are well chosen charts, graphs, tables and personnel forms which serve to accentuate the subject matter.

In Chapter 22 at its end, p. 501–503, are set forth seventeen items as ideals to strive for in personnel relations to establish Cooperation as a Keystone of Industrial Democracy which if they are striven for, and finally established by the teamwork of Management-Labor-Government, will produce in the United States a real industrial democracy. L.M.D.

276. Investigations into Causes and Control of Moulds in State Houses. R. M. Brien and R. W. Denne, Dept. Sci. and Indus. Res., New Zeal. New Zeal. Jour. Sci. and Technol., *26B*, No. 4: 174–181. Jan., 1945.

Sodium penta-chlor-phenate was added so as to have a two per cent concentration in the paste or distemper (paint). W.C.F.

277. **Packaging. I. Water-vapor Resistance of Cellulose-base Containers.** A. H. Woodcock, Marion G. Chapman and Jesse A. Pearce. Nat. Res. Lab., Ottawa, Canada. Canad. Jour. Res., *23*, No. 2: Sec. F: 108. 1945.

"Lacquers and resins coated on paper stocks were less effective water-vapor barriers than waxes. Wax coatings became more effective as the density of the base stocks increased. A flexible wax compound at 40 lb. per ream of 500 sheets 24 × 36 in. was found most satisfactory for coating 'cellophane.' Rectangular containers were found more suitable than cylindrical containers." O.R.I.

278. **Heating Foods From Within.** M. V. H. Prinz, Omar Inc., Omaha, Neb. Food in Canada, *4*, No. 11: *18*, No. 12: *12*, 1944, and *5*, No. 1: 14, 1945.

The principles involved in the "electronic" or high-frequency dielectric heating are described and the advantages and disadvantages outlined. The fact that heat is generated in every particle of the food is a unique advantage. Dielectric heating is more expensive than conventional methods and will likely remain so for some time largely because of the high initial cost of the equipment. The method is well suited to the disinfestation of insects in packaged foods and in the final dehydration of products which have been first partially dried by present-day methods. O.R.I.

279. **The Dairy Plant of the Future.** Anonymous. Natl. Butter and Cheese Jour., *36*, No. 5: 40. May, 1945.

Questions concerning the dairy plants of the future were directed to agricultural economists in the leading dairy states. In general, these men felt that local conditions would affect individual plants but that the trend will be toward larger, more diversified plants. These plants will be better equipped and have higher standards of quality. Well-managed drying plants will prosper. Some factories will partially process products, like condensed milk and cheese, and then send them to a large central plant for completion and packaging. W.V.P.

natural flavor . . .
low bacteria count

at VON ALLMEN BROS. DAIRY, Louisville, Ky.

"The high quality product we are producing with the Mojonnier 16-Second Pasteurizing System is the largest contributing factor in our growth, which more than doubled during the first year of our operation," said Mr. Julius Von Allmen, President.

Handling 5000 lbs. of milk per hour, practically all Von Allmen products are run through this system.

Write for full details today to:

MOJONNIER BROS. CO.
4601 W. OHIO STREET • CHICAGO 44, ILLINOIS

Mojonnier

SHORT-TIME PASTEURIZING SYSTEM

Your advertisement is being read in every State and in 25 Foreign Countries

The SIMPLE, FAST and THOROUGH

NEW 42nd DAIRYMEN'S PRESSURE WASHER
HANDLES 1/2-PINT, PINT, QUART and 2-QUART BOTTLES
and GALLON JUGS

Cherry-Burrell designed and engineered this bottle washer especially to meet the needs of smaller plants — and it does its job with complete efficiency and economy. In continuous operation a case of washed, rinsed and sterilized bottles is removed every 40 seconds. Yet its treatments are thorough and its wash, rinse and chlorine sterilizing pumps use very little power. An exclusive feature of the new 42nd Washer is the balanced door for each compartment. When the doors are down they serve as a tank cover; when a door is raised it completely closes off that compartment, eliminating any possibility of splash, regardless of the size bottles or type case being washed. No rubber splash baffles are required. The balanced doors also operate quick-opening butterfly valves, stopping the flow of solution or rinse water when the door is down and opening the valve when the door is raised. The tank is built of heavy all-welded steel boiler plate and provision has been made for the sterilization of cans and utensils.

Ask your Cherry-Burrell representative for prices and complete information — or drop us a card.

DON'T RELAX NOW! BUY MORE WAR BONDS.

CHERRY-BURRELL CORPORATION

Specialists in Equipment and Supplies for the Dairy Industry

427 WEST RANDOLPH STREET, CHICAGO 6, ILLINOIS

FACTORIES, WAREHOUSES, BRANCHES, OFFICES OR DISTRIBUTORS AT YOUR SERVICE IN 32 CITIES

Your advertisement is being read in every State and in 25 Foreign Countries

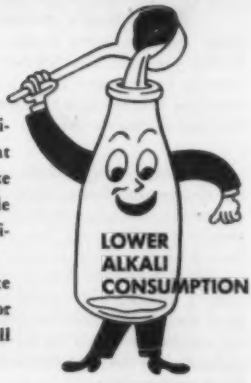
. . . Makes Brighter, Cleaner, Sterile Bottles!

Once you try Anchor Alkali in your washer, you'll say . . . a little Anchor Alkali goes a long way . . . makes bottles *brighter, cleaner, sterile* in shorter time!

Performance tests throughout the field *prove* that less Anchor Alkali is required to wash a given number of bottles in both hard and soft waters. That's because Anchor Alkali is in dustless, quick-dissolving flake form . . . each flake carrying the correct ratio of high cleansing elements.

Try Anchor Alkali and get maximum bottle washing efficiency at lower over-all cost! You'll also like Anchor Alkali because it reduces scale formation and acts as a superior lubricant for moving washer parts.

WRITE TODAY for complete folder which tells you how Anchor Alkali is used in dairy plants. Just fill in the coupon below.



for maximum
bottle washing efficiency . . .
maximum economy . . .
use Solvay Anchor Alkali

SOLVAY SALES CORPORATION, 40 Rector St., New York 6, N. Y.

Gentlemen: Kindly send me your complete folder describing Anchor Alkali for use in dairies.

Name.....

Affiliated with.....

Address.....

City..... *State*..... CX-8

Your advertisement is being read in every State and in 25 Foreign Countries

Purity Protected
to the last drop

A Seal-Kap's perfect closure on clear glass bottles assures the utmost health protection. And Seal-Kap protection is continuous from the moment it caps the bottle right through to the time the last drop is used.

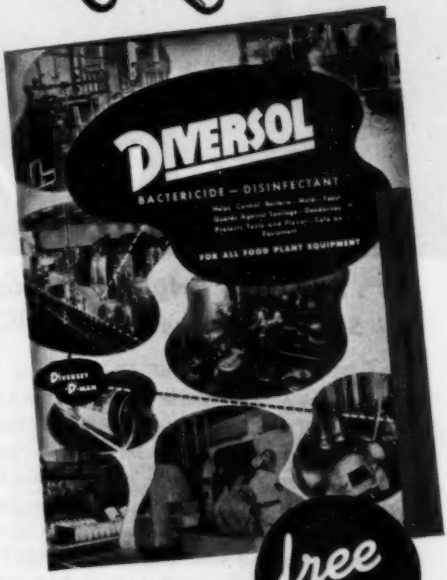
First, during handling and delivery, no dangerous impurities can touch the pouring lip because Seal-Kaps completely shield this vital area. Later, in the home, Seal-Kaps prevent wasteful, messy fork-prying because Seal-Kaps come off with only a quick, easy twist of the wrist. And tough, durable Seal-Kaps go back on again, as often as necessary with a tight-fitting snap, to prevent spilling and food contamination.

Today, more than ever, the nation needs all its vital milk supplies. Seal-Kaps keep pure milk pure right down to the last drop.

AMERICAN SEAL-KAP CORPORATION
11-05 44TH DRIVE, LONG ISLAND CITY 1, N. Y.

Bactericides *are* different

Here's proof!



10 REASONS WHY IN free **BULLETIN**

Send for this free bulletin. It shows why Diversol . . . with its 10 "action" features . . . is different from ordinary bactericides. A quick acting, crystal sodium hypochlorite, Diversol helps control bacteria, mold and yeast . . . guards against spoilage . . . helps protect taste and flavor. Softens hard water . . . leaves no film or scale. Send for your copy of this interesting bulletin, today. **The Diversey Corporation, 53 W. Jackson Blvd., Chicago 4, Ill.**

Your advertisement is being read in every State and in 25 Foreign Countries

"We have the saying, Plato: 'En la noche, todos los gatos son grises' . . . in the night, all cats are gray. The black cat, she is gray. The yellow cat, she is gray. Even the white cat."

"Si, Don Miguel, it is most confusing."

"Just so with the great variety of foods. In the half light of statistics, they all have the calories and vitamins and minerals."

"But there is one which stands out above the others?"

"Plato, if bread is the staff of life, then milk is life itself! And in ice-cream, America's Favorite, they use all forms of milk . . . the fluid milk and cream when meadows are lush and the feed is plentiful . . . the same dried milk solids that are fed to sturdy infants . . . the concentrated milk for added nourishment . . . even fine butter, on occasion, when there is no cream."

"Pasture-ized by the carefree cow, and pasteur-ized by careful men. What pun it is to talk with you!"

"Ave Maria, what childish nonsense . . . you must have a colt in the head."

"Purr-haps. But the difference between these cats would be brought out by more light in the spoken and the written words of the ice-cream makers. They should tell the public of *all* their so fine ingredients. Then, with the end of lend-lease and the war, we can have a land-let-loose for all-out production for peace. Nature and Science will combine in the making of billions of gallons of fine ice-cream!"

Mixevan—"America's Flavorite"
and other powdered vanilla products

DAVID MICHAEL & CO.

half a century in the flavoring field

Front and Master Streets, Philadelphia 22, Pa.

Your advertisement is being read in every State and in 25 Foreign Countries

Our bulletin 30c is fully descriptive—Write for it.

"THE GAULIN TWO STAGE HOMOGENIZER AND HIGH PRESSURE PUMPS have met the Dairy Industries needs for a durable, heavy duty and economical machine, since 1909. Homogenizers and Pumps are still available with proper priority ratings, as well as repair and replacement parts. Both machines are strictly sanitary and are approved by all leading health boards. The Homogenizers are built in sizes from 75 gallons to 2000 gallons per hour, and the High Pressure Pumps are custom built to suit individual needs. The Gaulin is the ideal, all-purpose machine for fluid milk, ice cream, evaporated milk, condensed milk and spray-drying milk or eggs."

MANTON-GAULIN
TWO STAGE
HOMOGENIZER

THE MANTON-GAULIN MFG. CO., INC.
7 CHARLTON STREET EVERETT, MASS., U.S.A.

To Make Easier the Speedy Removal of Butterfat Film

For fast, thorough maintenance cleaning results, arrange your daily clean-up routine to include efficient Oakite Composition No. 63. Specially designed for dairy equipment cleaning with high wetting-out and lime-solubilizing properties, Oakite Composition No. 63 makes easier the speedy removal of butterfat film and similar surface deposits. Oakite Composition No. 63 is exceptionally free-rinsing . . . safe to use.

We invite your inquiries about this widely-accepted dairy detergent. A free booklet covering the facts of Oakite Composition No. 63 will be gladly mailed at your request. Why not write TODAY?

OAKITE PRODUCTS, INC.,
Dairy Research Division,
160 THAMES STREET, NEW YORK 6, N. Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE CLEANING

NU-KLEEN

ORGANIC DETERGENT

For All Types of Equipment Cleaning by Hand

Simplify your cleaning problem by using this new effective organic detergent especially balanced for all hand cleaning operations. NU-KLEEN is one of today's most popular "acid" cleaners. Its organic acid content is skillfully adjusted to the wetting agent concentration providing the ideal amount of penetration and coverage. NU-KLEEN removes and prevents milkstone. It is free rinsing and leaves no film or other deposits. You can brush or spray NU-KLEEN with equally good results and do away with laborious old time cleaning methods. NU-KLEEN is non-corrosive and harmless to hands and clothing. Keep a supply on hand always for plant use and for your patrons' milking utensils and milking machines.

KLENZADE PRODUCTS, INC.
Beloit, Wisconsin

Your advertisement is being read in every State and in 25 Foreign Countries

PLAY IT SAFE!

When it comes to removing tarnish and milk-stone from cans and other dairy equipment, the demand is for a product *potent* enough to do the job thoroughly—yet *safe* on any surface. Famed for both speedy and safe cleansing properties are:

- **Wyandotte S. R.-10**—An odorless crystalline compound, expertly formulated for removing scale from heat exchangers, flash pasteurizers, milk cans and other equipment with milk-solid deposits. Readily soluble and easily handled.
- **Wyandotte G. L. X.***—A "sudsing," yet soapless cleaner, G. L. X. gives maximum cleaning efficiency without harm to glass, monel, tin, copper and stainless steel surfaces. Especially adapted to hard water, G. L. X. instantly banishes films, streaks, residues of any sort to leave spotless sanitation in its wake. Very easy to use.

S.R.-10 is especially useful for cleaning short-time plate heaters—either by itself, or with G. L. X. The Wyandotte Service Representative will be glad to work with you—not only on this but on *any* cleaning problem. His time, knowledge, experience are yours—without obligation.

* Registered trade-mark

Wyandotte
REG. U. S. PAT. OFF.

SERVICE REPRESENTATIVES IN 88 CITIES

WYANDOTTE CHEMICALS CORPORATION • J. B. FORD DIVISION • WYANDOTTE, MICHIGAN

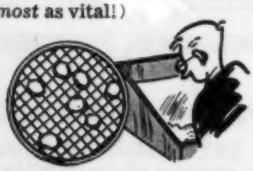
Your advertisement is being read in every State and in 25 Foreign Countries

HOW TO SEPARATE A CAT FROM A MOUSE

● Simply a matter of screening . . . a useful trick for a mouse to know. In fact, screening is a useful trick in any trade . . . even the salt business!

You see, in the salt business we've got to fit the salt to the job. Butter-makers don't want large, slow-dissolving crystals in Butter Salt. We remove the "big ones" so completely, you won't find even a trace on a 28-mesh Tylor screen. But they don't want fine dust, either, to cause pasting in the churn. Diamond Crystal Butter Salt contains only 3% of particles small enough to pass through a 65-mesh screen!

Yes, it's as vital to the butter-maker that we remove over-sized and under-sized salt crystals . . . as it is to the mouse to screen out that cat. (Well, *almost* as vital!)



Happily for the mouse, he got results. And so do we at Diamond Crystal. That's why you can always be sure of clean screening whenever you specify Diamond Crystal. Take your choice of grade or grain size—it's tops by actual tests!

Want Free Information on Salt? Write Us!

If *you* have a salt problem, let our Technical Director help! Just drop him a line in care of Diamond Crystal Salt, Dept, H-11, St. Clair, Michigan.

DIAMOND CRYSTAL
ALBERGER PROCESS **SALT**

FLAV-O-LAC FLAKES

THE CULTURE

of definitely better flavor & aroma-producing qualities.

The standard with foremost operators, agricultural schools & colleges.

FLAV-O-LAC FLAKES (shown) produce a quart of the finest starter on a single propagation. Single bottles $2.00.

SPECIAL FLAV-O-LAC FLAKES "40"

produce 40 quarts of starter on a single propagation. Single bottles $3.00

Free Culture Manual of Fermented Milk Products on request.

Pioneers in Spectro-chemical, Chemical and Fluoro-photometric Determinations of Vitamins A, B_1, B_2, Nicotinic Acid, Pantothenic Acid, B_6, C & E in Dairy and Food Products. (Vitamin D excluded) inquiries invited.

THE DAIRY LABORATORIES
DALARE ASSOCIATES
23rd & Locust Sts., Phila., Pa.
BRANCHES
New York Baltimore Washington
See our catalog in Dairy Industries Catalog.

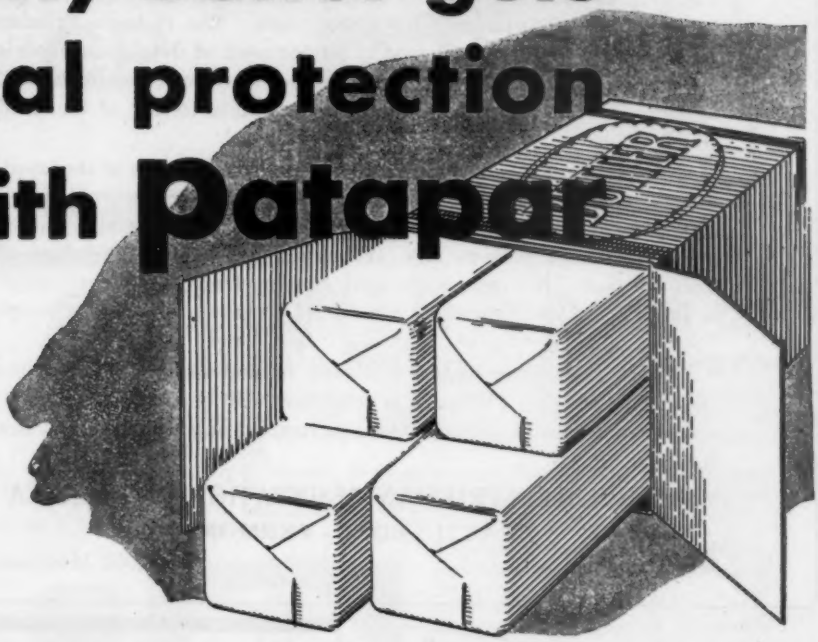
Marschall RENNET and COLOR

For best results in the cheese vat, specify Marschall's. High in strength, pure and uniform.

MARSCHALL DAIRY LABORATORY, INC.
MADISON 3, WISCONSIN

Your advertisement is being read in every State and in 25 Foreign Countries

Why butter gets real protection with Patapar



Patapar* Vegetable Parchment has qualities that protect flavor – help keep butter fresh and appetizing.

WET-STRENGTH – Patapar is never afraid of moisture. It is strong when wet – strong when boiled.

GREASE-RESISTANT–With its power to resist grease, Patapar guards against rancidity. The outer surface of Patapar keeps clean. Makes a pleasant package for housewives to handle.

ODORLESS, TASTELESS–Patapar doesn't impart that "papery" taste or odor. Butter keeps its original flavor.

TRANSLUCENT – Patapar's clear texture lends distinction to the package, yet it doesn't transmit harmful light.

PRINTING–Patapar can be beautifully printed in one or more colors. Inks used are harmless to taste, and have been specially developed to withstand moisture. Printing is done right in our own plants.

A Few of Patapar's uses:

Butter wrappers. Tub liners and circles. Printer box liners. Cheese wrappers and liners. Bulk corrugated box liners. Milk can gaskets. Milk bottle hoods. Ice cream wrappers and flavor labels.

Many users of Patapar include this nationally advertised Keymark on their printed wrappers as a symbol of protection.

*Reg. U. S. Pat. Off.

Paterson Parchment Paper Company • Bristol, Pennsylvania

Headquarters for Vegetable Parchment Since 1885

WEST COAST PLANT: 340 BRYANT STREET, SAN FRANCISCO 7, CALIFORNIA

BRANCH OFFICES: 120 BROADWAY, NEW YORK 5, N. Y. • 111 WEST WASHINGTON ST., CHICAGO 2, ILL.

Your advertisement is being read in every State and in 25 Foreign Countries

THE need for and the importance of setting up an "ideal" as a goal for breeders to achieve has long been recognized and the show ring has been used for this purpose for many years. The Holstein-Friesian Association of America was first to see the need of developing models and pictures of the ideal or True Type and these were completed and approved in 1922 and a pair of models was loaned to each of the Land Grant Colleges.

As a means of further improvement in the general type of the breed, the Association in 1929 established a program of herd inspection and classification. Inspection of the animals is made by specially trained and experienced persons who are nationally recognized judges of Holstein type. Six ratings are used, ranging from "excellent" which is the highest and represents a score of 90 points or more, through "very good," "good plus," "good," "fair," and "poor."

Herd classification enables a breeder to analyze his herd from the standpoint of type. When it is combined with production testing it serves as a means of proving sires and locating outstanding brood cow families.

THE HOLSTEIN-FRIESIAN ASSOCIATION OF AMERICA
BRATTLEBORO, VERMONT
Established in 1885 34,000 Members

"HANSEN'S" DAIRY PREPARATIONS

CHEESE RENNET AND COLOR
ANNATTO BUTTER COLOR
CERTIFIED BUTTER COLOR
ICE CREAM COLOR
LACTIC FERMENT CULTURE
BULGARIAN CULTURE

★

TESTING SOLUTIONS
RENNET TESTS

★

Chr Hansen's Laboratory, Inc.
Milwaukee 14, Wisconsin

Mention JOURNAL OF DAIRY SCIENCE When Answering Advertisements

This helps both the Advertiser and you

Your advertisement is being read in every State and in 25 Foreign Countries

CP DAIRY D

Vitamin D Concentrate of Guaranteed Potency

USE DAIRY-D To Tie Up With the Nation's Nutritional Program

● Public acceptance of Vitamin D Milk makes it highly desirable for every dairy to add this important nutritional product to the line. It will help sales and profits with a minimum of merchandising effort.

Dairy-D Vitamin D Concentrate is quickly and easily incorporated in the milk. No special equipment is needed. In the finished bottle of milk it is both odorless and tasteless. Dairy-D is reasonably priced.

To assure the potency of Dairy-D, each batch is biologically assayed twice before shipment . . . and given a lot number. Dairy-D Vitamin D Milk is approved by leading Public Health Officers. Dairies using Dairy-D are permitted to use the seal of acceptance of Council of Foods and Nutrition of the American Medical Association when application is approved.

Whether you are selling Vitamin D Milk or not, it will pay you to get the facts on Dairy-D now from your CP Representative.

Manufactured by

VITAMINS, INC., Chicago, Ill.

NATIONALLY DISTRIBUTED BY

THE CREAMERY PACKAGE MFG. COMPANY

1243 W. Washington Blvd., Chicago 7, Ill.

BRANCHES: Atlanta — Boston — Buffalo — Chicago — Dallas — Denver — Kansas City — Los Angeles — Minneapolis — New York — Omaha — Philadelphia — Portland, Oregon — Salt Lake City — San Francisco — Seattle — Toledo — Waterloo, Iowa

CREAMERY PACKAGE MFG. CO. OF CANADA, LTD.,
267 King St., West, Toronto 2, Ont., Canada

Your advertisement is being read in every State and in 25 Foreign Countries

DIFCO

CULTURE MEDIA
for Examination of Milk

Bacto-Tryptone Glucose Extract Agar

is recommended for use in determining the total bacterial plate count of milk in accordance with the procedures of "Standard Methods for the Examination of Dairy Products" of the American Public Health Association.

Upon plates of medium prepared from Bacto-Tryptone Glucose Extract Agar colonies of the bacteria occurring in milk are larger and more representative than those on media previously used for milk counts.

Bacto-Proteose Tryptone Agar

is recommended for use in determining the bacterial plate count of Certified Milk. The formula for this medium corresponds with that suggested in "Methods and Standards of Certified Milk" of the American Association of Medical Milk Commissions.

Bacto-Violet Red Bile Agar

is widely used for direct plate counts of coliform bacteria. Upon plates of this medium accurate counts of these organisms are readily obtained.

Bacto-Brilliant Green Bile 2% and
Bacto-Formate Ricinoleate Broth

are very useful liquid media for detection of coliform bacteria in milk. Use of these media is approved in "Standard Methods."

Specify "DIFCO"
THE TRADE NAME OF THE PIONEERS
In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

DIFCO LABORATORIES
INCORPORATED
DETROIT 1, MICHIGAN

Your advertisement is being read in every State and in 25 Foreign Countries